

SAFETY.CAT.COM™

MAINTENANCE INTERVALS

Operation and Maintenance
Manual Excerpt



Operation and Maintenance Manual

C6.6 Marine Generator Set

C6T1-Up (Generator Set)

Maintenance Recommendations

General Maintenance Information

SMCS Code: 4450; 7000

Note: Read the warnings and read the instructions that are contained in the Safety Section of this manual. These warnings and instructions must be understood before you perform any operation or any maintenance procedures.

Rotating electric machines are complex structures that are exposed to the following forms of stress:

- mechanical
- electrical
- thermal
- environmental

These stresses may be of varying magnitudes. The electrical insulation systems are very susceptible to damage that is caused by the stresses that are listed above. Exposure to these stresses may shorten the effective life of the electrical insulation system. Therefore, the service life of an electric machine will largely depend on the serviceability of the electrical insulation systems. An inspection program and a testing procedure are recommended. An inspection program and a testing procedure will ensure that the equipment is maintained in satisfactory condition. This will increase field reliability.

A regular maintenance and inspection program can provide an evaluation of the present condition of the equipment. A regular maintenance program and a regular inspection program can also reveal future problems. The frequency of this maintenance program will depend on the following factors:

- application
- environmental conditions
- operator's experience
- operator's philosophy

A regular maintenance program is strongly recommended. This program would involve the following steps:

- periodic disassembly

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- knowledgeable visual examination of the equipment
- the application of electrical tests

Never perform a test over the rated potential. These tests can damage insulation that is contaminated or insulation that is in marginal condition. For more information, refer to "I.E.E.E. Standard 432-1992" or consult a Caterpillar dealer.

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System Pressure Release

SMCS Code: 1250; 1300; 1350; 5050

Coolant System

WARNING

Pressurized system: Hot coolant can cause serious burn. To open cap, stop engine, wait until radiator is cool. Then loosen cap slowly to relieve the pressure.

The engine can have the ability to auto start. Ensure that the power supply is isolated before any service or repair is performed.

To relieve the pressure from the coolant system, turn off the engine. Allow the cooling system pressure cap to cool. Remove the cooling system pressure cap slowly in order to relieve pressure.

Fuel System

To relieve the pressure from the fuel system, turn off the engine.

High Pressure Fuel Lines

WARNING

Contact with high pressure fuel may cause fluid penetration and burn hazards. High pressure fuel spray may cause a fire hazard. Failure to follow these inspection, maintenance and service instructions may cause personal injury or death.

The high pressure fuel lines are the fuel lines that are between the high pressure fuel pump and the high pressure fuel manifold and the fuel lines that are between the fuel manifold and cylinder head. These fuel lines are different from fuel lines on other fuel systems.

This is because of the following differences:

- The high pressure fuel lines are constantly charged with high pressure.
- The internal pressures of the high pressure fuel lines are higher than other types of fuel system.

Before any service or repair is performed on the engine fuel lines, perform the following tasks:

1. Stop the engine.
2. Wait for 60 seconds.

Do not loosen the high pressure fuel lines in order to remove air from the fuel system.

Engine Oil

To relieve pressure from the lubricating system, turn off the engine.

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Welding on Engines with Electronic Controls

SMCS Code: 1000

NOTICE

Because the strength of the frame may decrease, some manufacturers do not recommend welding onto a chassis frame or rail. Consult the OEM of the equipment or your Caterpillar dealer regarding welding on a chassis frame or rail.

Proper welding procedures are necessary in order to avoid damage to the engine's ECM, sensors, and associated components. When possible, remove the component from the unit and then weld the component. If removal of the component is not possible, the following procedure must be followed when you weld on a unit that is equipped with a Caterpillar Electronic Engine. The following procedure is considered to be the safest procedure to weld on a component. This procedure should provide a minimum risk of damage to electronic components.

NOTICE

Do not ground the welder to electrical components such as the ECM or sensors. Improper grounding can cause damage to the drive train bearings, hydraulic components, electrical components, and other components.

Clamp the ground cable from the welder to the component that will be welded. Place the clamp as close as possible to the weld. This will help reduce the possibility of damage.

Note: Perform the welding in areas that are free from explosive hazards.

1. Stop the engine. Turn the switched power to the OFF position.
2. Disconnect the negative battery cable from the battery. If a battery disconnect switch is provided, open the switch.
3. Disconnect the J1/P1 and J2/P2 connectors from the ECM. Move the harness to a position that will not allow the harness to accidentally move back and make contact with any of the ECM pins.

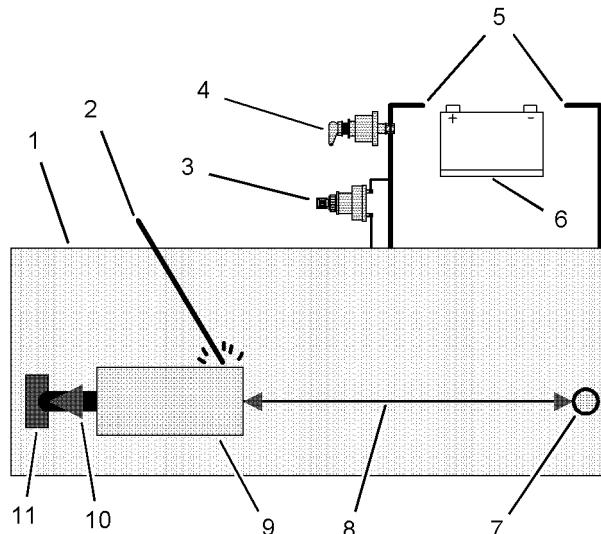


Illustration 71

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Use the example above. The current flow from the welder to the ground clamp of the welder will not cause damage to any associated components.

- (1) Engine
- (2) Welding electrode
- (3) Keyswitch in the OFF position
- (4) Battery disconnect switch in the open position
- (5) Disconnected battery cables
- (6) Battery
- (7) Electrical/Electronic component
- (8) Minimum distance between the component that is being welded and any electrical/electronic component
- (9) The component that is being welded
- (10) Current path of the welder
- (11) Ground clamp for the welder

4. Connect the welding ground cable directly to the part that will be welded. Place the ground cable as close as possible to the weld in order to reduce the possibility of welding current damage to bearings, hydraulic components, electrical components, and ground straps.

Note: If electrical/electronic components are used as a ground for the welder, or electrical/electronic components are located between the welder ground and the weld, current flow from the welder could severely damage the component.

5. Protect the wiring harness from welding debris and spatter.
6. Use standard welding practices to weld the materials.

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Generator Start-up Checklist

SMCS Code: 4450

Table 15

GENERATOR START-UP CHECKLIST						
RATING INFORMATION						
Engine Serial Number: _____				Arrangement Number: _____		
Generator Serial Number: _____				Arrangement Number: _____		
GENERATOR NAME PLATE INFORMATION						
Voltage: _____			Package (prime, continuous, standby): _____			
Amperage: _____			Kilowatts: _____			
Storage Location:						
Main Stator Megohmmeter Reading:	Before Storage:			After Storage:		
Generator dried for 24 hours prior to startup?			(Y/N)		Drying method:	
SPACE HEATERS	Yes	No	Comments			
Space heaters operating properly?						
Space heater operated 48 hours before startup?						
MEGOHMMETER TEST Special Instruction, SEHS9124	30 sec. reading	60 sec. reading	30 sec. corrected	60 sec. corrected	Ambient temp.	Comments
Beginning of Storage	Main Stator					
	Main Rotor					
	Exciter Stator					
	Exciter Rotor					
	PMG Stator					
Start-up	Main Stator					
	Main Rotor					
	Exciter Stator					
	Exciter Rotor					
	PMG Stator					

Table 16

GENERATOR START-UP CHECKLIST (CONT.)					
		Regulator	Voltage	Amps	Comments
No Load	All Frames	F1 to F2	DC		
		E1 to E2	AC		
		E1 to E3	AC		
		E2 to E3	AC		
	2400, 2500, 2800, and 2900 Frames	PM1 to PM4	AC		
	2600 Frame	PM1 to PM2	AC		
		PM1 to PM3	AC		
		PM2 to PM3	AC		
Full Load	All Frames	Generator Excitation Name Plate Information:	DC		Compare with F1 to F2
		F1 to F2	DC		
		E1 to E2	AC		
		E1 to E3	AC		
		E2 to E3	AC		
	2400, 2500, 2800, and 2900 Frames	PM1 to PM4	AC		
	2600 Frame	PM1 to PM2	AC		
		PM1 to PM3	AC		
		PM2 to PM3	AC		

Table 17

GENERATOR START-UP CHECKLIST (CONT.)				
ELECTRICAL		Yes	No	Comments
	Unit properly grounded			
	Check diodes			
	Over current protection			
	Over voltage protection			
	Check for loose wiring			
	Adjust voltage			
	Adjust frequency			

Table 18

GENERATOR START-UP CHECKLIST (CONT.)																																				
MECHANICAL			Data		Comments																															
Bearing temperature readings at full load			Front _____ Rear _____																																	
			A0 _____ B0 _____ C0 _____																																	
			Top _____ Bottom _____																																	
			Top _____ Bottom _____																																	
			Top _____ Bottom _____																																	
			Temperature _____																																	
			Size of Opening _____																																	
SWITCH GEAR/PARALLEL OPERATION																																				
Manufacturer: <table border="1"> <thead> <tr> <th></th> <th>Setting 1</th> <th>Setting 2</th> <th>Setting 3</th> <th>Comments</th> </tr> </thead> <tbody> <tr> <td>Type of Circuit breaker</td><td></td><td></td><td></td><td></td></tr> <tr> <td>Overload setting</td><td></td><td></td><td></td><td></td></tr> <tr> <td>Reverse power relay</td><td></td><td></td><td></td><td></td></tr> <tr> <td>VAR/PF Controller</td><td></td><td></td><td></td><td></td></tr> <tr> <td>Load share</td><td></td><td></td><td></td><td></td></tr> </tbody> </table>								Setting 1	Setting 2	Setting 3	Comments	Type of Circuit breaker					Overload setting					Reverse power relay					VAR/PF Controller					Load share				
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VAR/PF Controller																																				
Load share																																				
INSTALLATION & LOAD INFORMATION																																				
Neutral grounding system			UPS																																	
Enclosure type			- Size																																	
Motor:			Other loads:																																	
- Total SKVA			- Lighting																																	
- Total HP			- Computers																																	
			- Welding																																	
			- Non-linear																																	
			- Other																																	
FULL LOAD DATA																																				
Voltage	Amps		KW	KVARS	P.F.																															

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Maintenance Interval Schedule

SMCS Code: 1000; 7500

Ensure that all safety information, warnings, and instructions are read and understood before any operation or any maintenance procedures are performed.

When Required

Battery - Replace	114
Battery or Battery Cable - Disconnect	115
Engine - Clean	128
Fuel System - Prime	138
Fuel System - Prime	139
Generator - Dry	150
Generator Load - Check	153
Generator Set - Test	153
Rotating Rectifier - Check	164
Rotating Rectifier - Test	164
Sea Water Strainer - Clean/Inspect	165
Severe Service Application - Check	165

Daily

Cooling System Coolant Level - Check	124
Electrical Connections - Check	128
Engine Air Cleaner Service Indicator - Inspect ...	129
Engine Oil Level - Check	131
Fuel System Primary Filter/Water Separator - Drain	146
Fuel Tank Water and Sediment - Drain	150
Generator - Inspect	151
Power Factor - Check	163
Walk-Around Inspection	167

Every Week

Automatic Start/Stop - Inspect	113
Bearing Temperature - Measure/Record	116
Hoses and Clamps - Inspect/Replace	155
Instrument Panel - Inspect	156
Jacket Water Heater - Check	160
Standby Generator Set Maintenance Recommendations	166

Every 250 Service Hours

Cooling System Coolant Sample (Level 1) - Obtain	125
Engine Oil Sample - Obtain	131

Initial 500 Service Hours

Engine Valve Lash - Inspect/Adjust	138
------------------------------------------	-----

Every 500 Service Hours

Belts - Inspect/Adjust/Replace	116
Belts - Inspect/Adjust/Replace	118

Engine Crankcase Breather - Replace	130
Engine Oil and Filter - Change	132
Engine Oil and Filter - Change	134
Fuel System Primary Filter (Water Separator) Element - Replace	143
Fuel System Secondary Filter - Replace	147

Every 500 Service Hours or 1 Year

Auxiliary Water Pump - Inspect	113
Battery Electrolyte Level - Check	115
Cooling System Supplemental Coolant Additive (SCA) - Test/Add	126
Engine Air Cleaner Element - Clean/Replace	129
Radiator - Clean	163
Sea Water Strainer - Clean/Inspect	165

Every 1000 Service Hours

Aftercooler Condensate Drain Valve - Inspect/Clean	112
Engine Valve Lash - Inspect/Adjust	138
Magnetic Pickups - Clean/Inspect	160
Water Pump - Inspect	169

Every 1000 Service Hours or 1 Year

Battery Charger - Check	115
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Every 2000 Service Hours

Engine Mounts - Inspect	130
Heat Exchanger - Inspect	154
Insulation - Test	157
Starting Motor - Inspect	167
Turbocharger - Inspect	167

Every 2000 Service Hours or 1 Year

Alternator - Inspect	113
Generator Set Vibration - Inspect	154

Every Year

Cooling System Coolant Sample (Level 2) - Obtain	126
--------------------------------------------------------	-----

Every 3000 Service Hours or 2 Years

Cooling System Coolant (DEAC) - Change	119
Cooling System Water Temperature Regulator - Replace	128

Every 3000 Service Hours or 3 Years

Engine Protective Devices - Check	138
-----------------------------------------	-----

Every 4000 Service Hours

Aftercooler Core - Clean/Test	112
-------------------------------------	-----

Every 6000 Service Hours or 3 Years

Cooling System Coolant Extender (ELC) - Add .. 124

Every 12 000 Service Hours or 6 Years

Cooling System Coolant (ELC) - Change 122

Overhaul

Overhaul Considerations 160

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Aftercooler Condensate Drain Valve - Inspect/Clean

SMCS Code: 1063-042-DN, VL

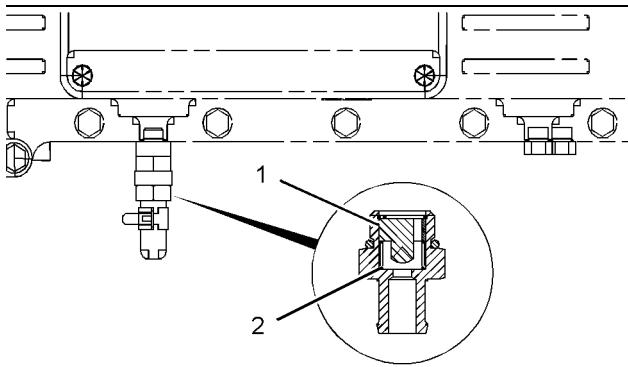


Illustration 72

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(1) Plunger
(2) Valve seat

The boost pressure forces plunger (1) to move down on valve seat (2). The plunger must close against the seat at a pressure of 27.5 kPa (4 psi). When the engine is stopped, the absence of boost pressure allows the plunger to rise to the open position. This allows the condensation from the aftercooler to drain out.

The plunger must be able to move freely in order to close the system when the engine is running. The plunger must be able to move freely in order to allow condensation to drain from the aftercooler when the engine is stopped. Residue from normal engine operation could cause the plunger to stick.

1. Remove the valve from the housing. Check the valve in order to determine if the plunger moves freely. If the plunger does not move easily, clean the valve with solvent.
2. Reassemble the aftercooler condensate drain valve. Refer to the Specifications, SENR3130, "Torque Specifications".

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Aftercooler Core - Clean/Test

SMCS Code: 1064-070; 1064-081

1. Remove the core. Refer to the Service Manual for the procedure.
2. Turn the aftercooler core upside-down in order to remove debris.

NOTICE

Do not use a high concentration of caustic cleaner to clean the core. A high concentration of caustic cleaner can attack the internal metals of the core and cause leakage. Only use the recommended concentration of cleaner.

3. Back flush the core with cleaner.

Caterpillar recommends the use of Hydrosolv liquid cleaner. Table 19 lists Hydrosolv liquid cleaners that are available from your Caterpillar dealer.

Table 19

Hydrosolv Liquid Cleaners ⁽¹⁾		
Part Number	Description	Size
1U-5490	Hydrosolv 4165	19 L (5 US gallon)
174-6854	Hydrosolv 100	19 L (5 US gallon)

(1) Use a two to five percent concentration of the cleaner at temperatures up to 93°C (200°F). Refer to Application Guide, NEHS0526 or consult your Caterpillar dealer for more information.

4. Steam clean the core in order to remove any residue. Flush the fins of the aftercooler core. Remove any other trapped debris.
5. Wash the core with hot, soapy water. Rinse the core thoroughly with clean water.

WARNING

Personal injury can result from air pressure.

Personal injury can result without following proper procedure. When using pressure air, wear a protective face shield and protective clothing.

Maximum air pressure at the nozzle must be less than 205 kPa (30 psi) for cleaning purposes.

6. Dry the core with compressed air. Direct the air in the reverse direction of the normal flow.
7. Inspect the core in order to ensure cleanliness. Pressure test the core. Many shops that service radiators are equipped to perform pressure tests. If necessary, repair the core.
8. Install the core. Refer to the Service Manual for the procedure.

For more information on cleaning the core, consult your Caterpillar dealer.

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Alternator - Inspect

SMCS Code: 1405-040

Caterpillar recommends a scheduled inspection of the alternator. Inspect the alternator for loose connections and proper battery charging. Inspect the ammeter (if equipped) during engine operation in order to ensure proper battery performance and/or proper performance of the electrical system. Make repairs, as required.

Check the alternator and the battery charger for proper operation. If the batteries are properly charged, the ammeter reading should be very near zero. All batteries should be kept charged. The batteries should be kept warm because temperature affects the cranking power of the battery. If the battery is too cold, the battery will not crank the engine.

When the engine is not run for long periods of time or if the engine is run for short periods, the batteries may not fully charge. A battery with a low charge will freeze more easily than a battery with a full charge.

Inspect the components of the pump more frequently when the pump is exposed to debris, sand, or other abrasive materials. Inspect the components if the pump is operating at a differential pressure of more than 103 kPa (15 psi).

Check the following components for wear and check the following components for damage:

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Automatic Start/Stop - Inspect

SMCS Code: 4462

The generator set must be ready to operate under a load at any time. After performing maintenance on the generator set, inspect the position of the control switches. Ensure the following conditions:

- The starting system is enabled.
- The control switches are in the correct position for automatic starting.
- The switchgear and the automatic transfer switches that are associated with the generator are enabled.

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Auxiliary Water Pump - Inspect

SMCS Code: 1371-040

Impellers require periodic inspection and seals require periodic inspection. Impellers have a service life that is limited. The service life depends on the engine operating conditions.

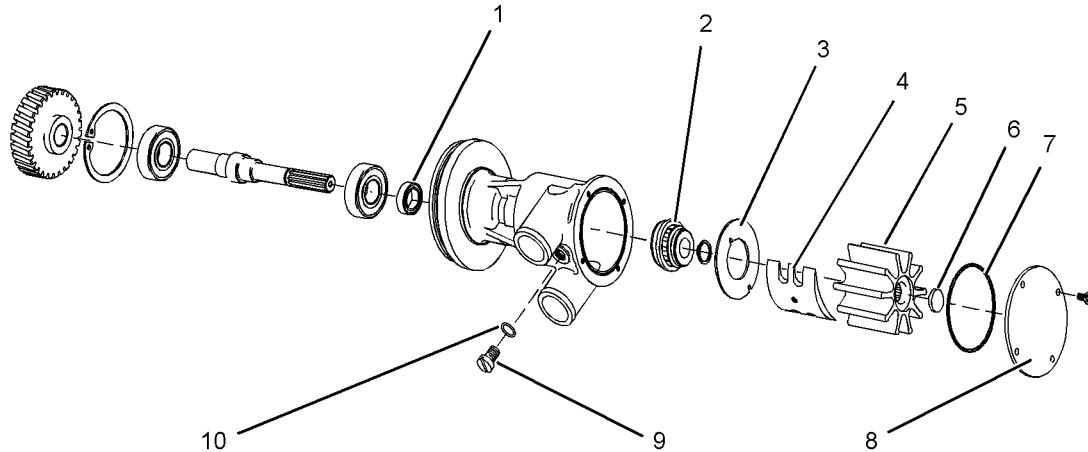


Illustration 73

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- (1) Seal
- (2) Seal
- (3) Wear Plate
- (4) Cam
- (5) Impeller
- (6) Seal
- (7) O Ring Seal
- (8) End Cover

- (9) Screw that holds cam
- (10) O Ring Seal

- Cam
- Impeller
- Seals
- Wear plate

If wear is found or if damage is found, replace the components which are worn or replace the components which are damaged. Use the proper repair kit for the pump. Refer to the Disassembly and Assembly for more information on servicing the auxiliary water pump.

i02322315

Battery - Replace

SMCS Code: 1401-510

WARNING

Batteries give off combustible gases which can explode. A spark can cause the combustible gases to ignite. This can result in severe personal injury or death.

Ensure proper ventilation for batteries that are in an enclosure. Follow the proper procedures in order to help prevent electrical arcs and/or sparks near batteries. Do not smoke when batteries are serviced.

WARNING

The battery cables or the batteries should not be removed with the battery cover in place. The battery cover should be removed before any servicing is attempted.

Removing the battery cables or the batteries with the cover in place may cause a battery explosion resulting in personal injury.

1. Switch the engine to the OFF position. Remove all electrical loads.
2. Turn off any battery chargers. Disconnect any battery chargers.
3. The NEGATIVE “-” cable connects the NEGATIVE “-” battery terminal to the NEGATIVE “-” terminal on the starting motor. Disconnect the cable from the NEGATIVE “-” battery terminal.
4. The POSITIVE “+” cable connects the POSITIVE “+” battery terminal to the POSITIVE “+” terminal on the starting motor. Disconnect the cable from the POSITIVE “+” battery terminal.

Note: Always recycle a battery. Never discard a battery. Dispose of used batteries to an appropriate recycling facility.

5. Remove the used battery.
6. Install the new battery.

Note: Before the cables are connected, ensure that the engine start switch is OFF.

7. Connect the cable from the starting motor to the POSITIVE "+" battery terminal.
8. Connect the NEGATIVE "-" cable to the NEGATIVE "-" battery terminal.

i01942625

Battery Charger - Check

SMCS Code: 1401-535

Check the battery charger for proper operation. If the batteries are properly charged, the needle of the ammeter will register near "0" (zero).

The batteries should be kept warm, when possible. The temperature of the battery will affect cranking power. A battery that is too cold will not crank the engine, even if the engine is warm.

The batteries may not fully recharge when the engine is not run for long periods of time. The batteries may not fully recharge if the engine only runs for short periods. Ensure a full charge in order to help prevent the battery from freezing.

i02724529

Battery Electrolyte Level - Check

SMCS Code: 1401-535

When the engine is not run for long periods of time or when the engine is run for short periods, the batteries may not fully recharge. Ensure a full charge in order to help prevent the battery from freezing. If batteries are properly charged, ammeter reading should be very near zero, when the engine is in operation.

⚠ WARNING

All lead-acid batteries contain sulfuric acid which can burn the skin and clothing. Always wear a face shield and protective clothing when working on or near batteries.

1. Remove the filler caps. Maintain the electrolyte level to the "FULL" mark on the battery.

If the addition of water is necessary, use distilled water. If distilled water is not available use clean water that is low in minerals. Do not use artificially softened water.

2. Check the condition of the electrolyte with the 245-5829 Coolant Battery Tester Refractometer.

3. Keep the batteries clean.

Clean the battery case with one of the following cleaning solutions:

- Use a solution of 0.1 kg (0.2 lb) baking soda and 1 L (1 qt) of clean water.
- Use a solution of ammonium hydroxide.

Thoroughly rinse the battery case with clean water.

Use a fine grade of sandpaper to clean the terminals and the cable clamps. Clean the items until the surfaces are bright or shiny. DO NOT remove material excessively. Excessive removal of material can cause the clamps to not fit properly. Coat the clamps and the terminals with 5N-5561 Silicone Lubricant, petroleum jelly or MPGm.

i02323088

Battery or Battery Cable - Disconnect

SMCS Code: 1402-029

⚠ WARNING

The battery cables or the batteries should not be removed with the battery cover in place. The battery cover should be removed before any servicing is attempted.

Removing the battery cables or the batteries with the cover in place may cause a battery explosion resulting in personal injury.

1. Turn the start switch to the OFF position. Turn the ignition switch (if equipped) to the OFF position and remove the key and all electrical loads.
2. Disconnect the negative battery terminal. Ensure that the cable cannot contact the terminal. When four 12 volt batteries are involved, two negative connection must be disconnected.
3. Remove the positive connection.
4. Clean all disconnected connection and battery terminals.

5. Use a fine grade of sandpaper to clean the terminals and the cable clamps. Clean the items until the surfaces are bright or shiny. DO NOT remove material excessively. Excessive removal of material can cause the clamps to not fit correctly. Coat the clamps and the terminals with a suitable silicone lubricant or petroleum jelly.
6. Tape the cable connections in order to help prevent accidental starting.
7. Proceed with necessary system repairs.
8. In order to connect the battery, connect the positive connection before the negative connector.

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Bearing Temperature - Measure/Record

SMCS Code: 4471-082-TA

Bearing temperature detectors are optional on all Caterpillar generators. These detectors are 100 ohm resistance temperature detectors. The optional monitoring for the generator bearing temperature may be available in the EMCP 3 control panel. Bearing temperature detectors may be used with equipment that has been provided by the customer in order to measure the bearing temperature. Bearing temperature detectors may help to prevent premature bearing failure.

A sudden increase in bearing temperature may indicate impending bearing failure.

For applications that require multiple drive belts, replace the belts in matched sets. Replacing only one belt of a matched set will cause the new belt to carry more load because the older belt is stretched. The additional load on the new belt could cause the new belt to break.

If the belts are too loose, vibration causes unnecessary wear on the belts and pulleys. Loose belts may slip enough to cause overheating.

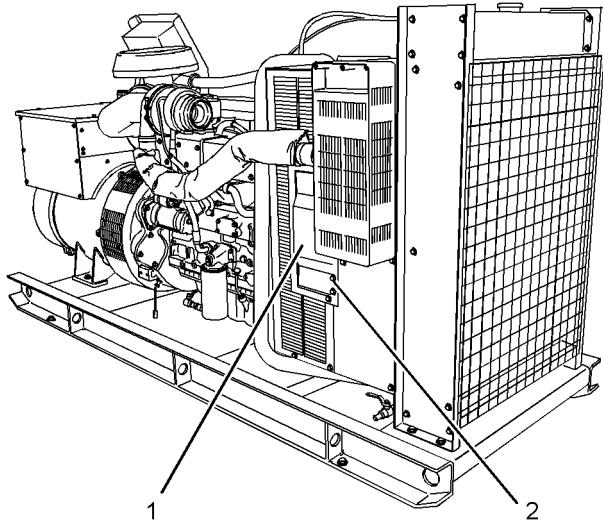


Illustration 74

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Typical example

1. Remove the bolts (2).
2. Remove the radiator guard (1).

After inspection of the belt or adjustment of the belt, install the guard.

i03069821

Belts - Inspect/Adjust/Replace (Two Belt Set)

SMCS Code: 1357-025; 1357-040; 1357-510

Note: The engine may have the ability to auto start. Ensure that the power is isolated before any service or repair is performed.

Inspection

To maximize the engine performance, inspect the belts for wear and for cracking. Replace belts that are worn or damaged.

Adjustment

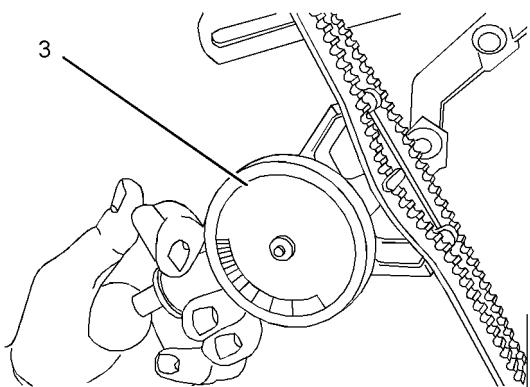


Illustration 75

g01626059

Typical example

3. To accurately check the belt tension, install 144-0235 Belt Tension Gauge. Install the gauge (3) at the center of the longest free length and check the tension.

The correct tension for a used belt is 355 N (79.8 lb). If the tension of the belt is below 250 N (56 lb) adjust the belt to 355 N (79.8 lb).

The correct tension for a new belt or new belts is 535 N (120 lb). A higher tension is required in order to compensate for the stretch that is in a new belt. Only use the higher tension on a belt that has not been used. A used belt is a belt that has been in operation for 30 minutes or a longer period of time.

4. Align the guard (1) to the engine. Install the bolts (2). Tighten the bolts securely.

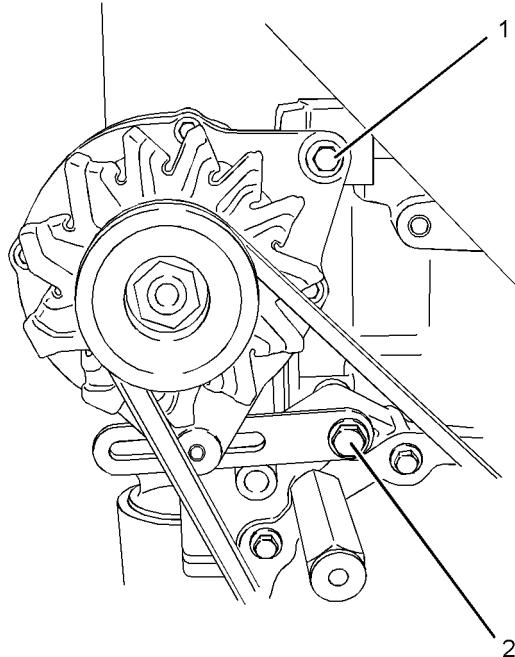


Illustration 76

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1. Loosen the nut and bolt (1). Then loosen the nut and bolt (2).

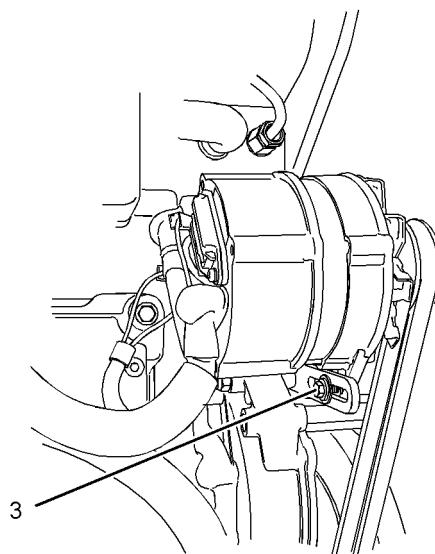


Illustration 77

g01558693

Typical example

2. Loosen bolt (3) and adjust the alternator in order to alter the belt tension. Tighten all bolts for the adjustment of the alternator to 22 N·m (16 lb ft).

3. Install the radiator guard . Refer to "Inspection" for more information.

Replace

Refer to Disassembly and Assembly manual, "V belt Remove and Install" for more information.

i03070444

Belts - Inspect/Adjust/Replace (Single Belt)

SMCS Code: 1357-025; 1357-040; 1357-510

Note: The engine may have the ability to auto start. Ensure that the power supply is isolated before any service or repair is performed.

Inspection

To maximize the engine performance, inspect the belt for wear and for cracking. Replace a belt that is worn or damaged.

If the belt is too loose, vibration causes unnecessary wear on the belt and the pulley.

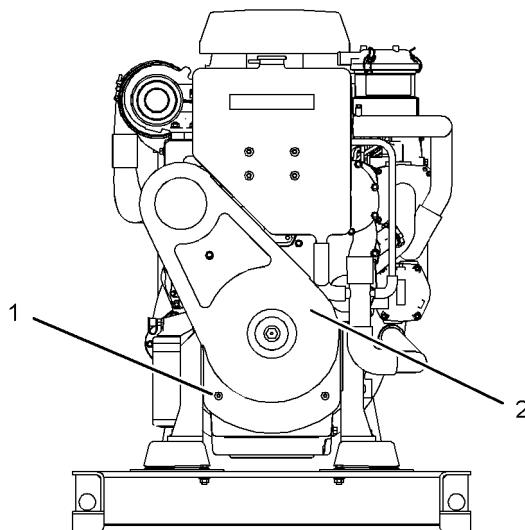


Illustration 78

Typical example

g01560847

1. Remove the bolts (1) and remove the guard (2).

After inspection of the belt or adjustment of the belt, install the guard.

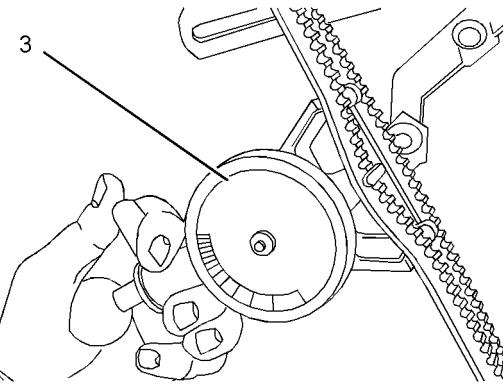


Illustration 79

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2. To accurately check the belt tension, install 144-0235 Belt Tension Gauge. Install the gauge (3) at the center of the longest free length and check the tension.

The correct tension for a used belt is 355 N (79.8 lb). If the tension of the belt is below 250 N (56 lb) adjust the belt to 355 N (79.8 lb).

The correct tension for a new belt or new belts is 535 N (120 lb). A higher tension is required in order to compensate for the stretch that is in a new belt. Only use the higher tension on a belt that has not been used. A used belt is a belt that has been in operation for 30 minutes or a longer period of time.

3. Align the guard (2) to the engine. Install the bolts (1). Tighten the bolts securely.

Adjustment

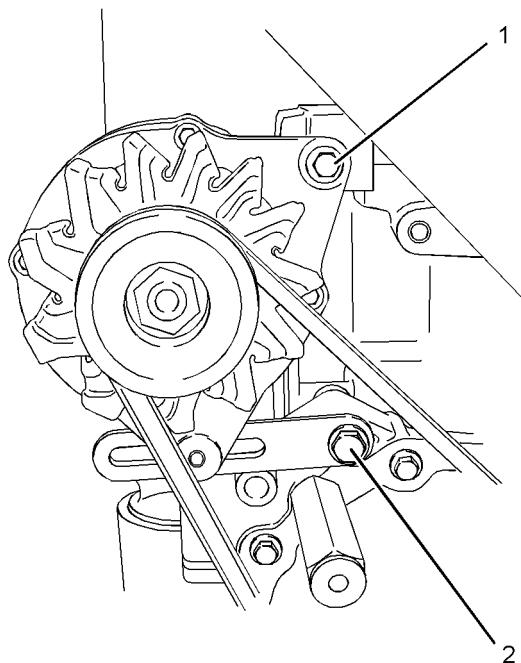


Illustration 80

g01560846

1. Loosen the nut and bolt (1). Then loosen the nut and bolt (2).

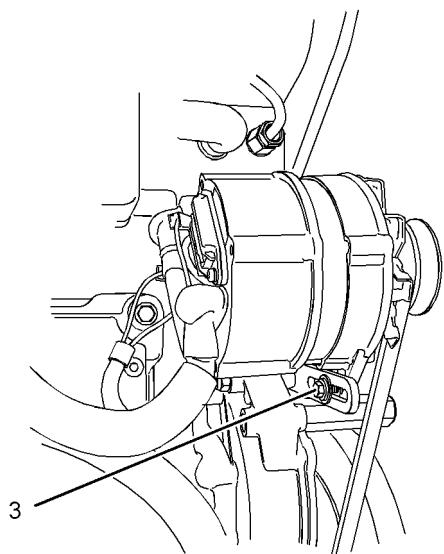


Illustration 81

g01626064

2. Loosen bolt (3) and adjust the alternator in order to alter the belt tension. Tighten all bolts for the adjustment of the alternator to 22 N·m (16 lb ft).

3. Install the cover. Refer to "Inspection" for more information.

Replace

Refer to Disassembly and Assembly manual, "V belt Remove and Install" for more information.

i03144032

Cooling System Coolant (DEAC) - Change

SMCS Code: 1350-070; 1395-044

Clean the cooling system and flush the cooling system before the recommended maintenance interval if the following conditions exist:

- The engine overheats frequently.
- Foaming is observed.
- The oil has entered the cooling system and the coolant is contaminated.
- The fuel has entered the cooling system and the coolant is contaminated.

NOTICE

Use of commercially available cooling system cleaners may cause damage to cooling system components. Use only cooling system cleaners that are approved for Caterpillar engines.

Note: Inspect the water pump and the water temperature regulator after the cooling system has been drained. This is a good opportunity to replace the water pump, the water temperature regulator and the hoses, if necessary.

Drain

WARNING

Pressurized System: Hot coolant can cause serious burns. To open the cooling system filler cap, stop the engine and wait until the cooling system components are cool. Loosen the cooling system pressure cap slowly in order to relieve the pressure.

Note: The engine may have the ability to auto start. Ensure that the power is isolated before any service or repair is performed.

1. Stop the engine and allow the engine to cool. Turn the isolator keyswitch to the OFF position.

2. Loosen the cooling system filler cap slowly in order to relieve any pressure. Remove the cooling system filler cap.

Note: Refer to Operation and Maintenance Manual, "General Hazard Information" for information on Containing Fluid Spillage.

3. Open the cooling system drain valves. If the cooling system is not equipped with a drain valve, remove one of the drain plugs.

Note: Drain the engine coolant from the following positions. Rear of engine block, Bottom of the heat exchanger, and the underside of the exhaust manifold. The exhaust manifold may have two drains. The exhaust manifold that is installed on a engine that has a MCS control panel will only have one drain.

Allow the coolant to drain into a suitable container.

4. Properly dispose of the drained material. Obey local regulations for the disposal of the material.

NOTICE

Dispose of used engine coolant properly or recycle. Various methods have been proposed to reclaim used coolant for reuse in engine cooling systems. The full distillation procedure is the only method acceptable by Caterpillar to reclaim the used coolant.

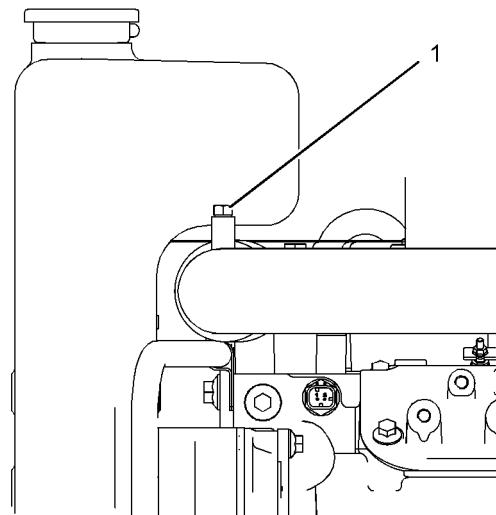


Illustration 82

g01618492

Typical example

3. Open the vent screw (1) enough to allow the air that is trapped to be purged from the system.
4. Fill the cooling system with a mixture of clean water and Caterpillar Fast Acting Cooling System Cleaner. Add 0.5 L (1 pint) of cleaner per 15 L (4 US gal) of the cooling system capacity.

Flush

1. Flush the cooling system with clean water in order to remove any debris.
2. Close the drain valves. Clean the drain plugs. Install the drain plugs. Refer to Torque Specifications, SENR3130 for more information on the correct torques.

NOTICE

Do not fill the cooling system faster than 5 L (1.3 US gal) per minute to avoid air locks.

Cooling system air locks may result in engine damage.

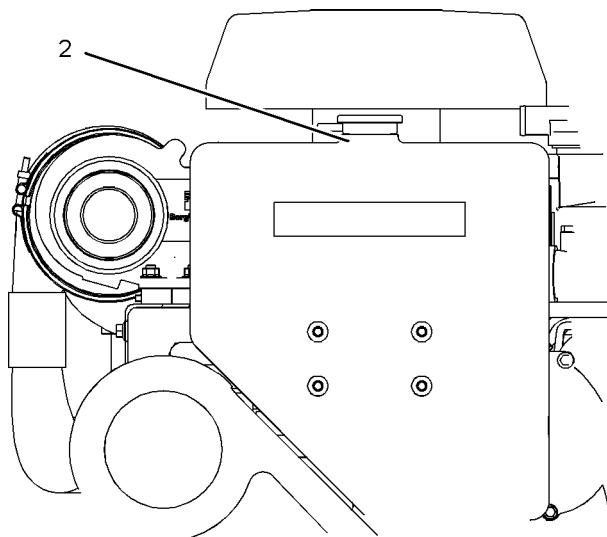


Illustration 83

g01618504

5. Tighten the vent screw securely. Ensure that the coolant level is 25 mm (0.9843 inch) below filler neck (2) on the header tank or the radiator.

6. Install the cooling system filler cap. Operate the engine without load for approximately 30 minutes, in order to allow circulation. The coolant temperature should be at least 82 °C (180 °F).

NOTICE

Improper or incomplete rinsing of the cooling system can result in damage to copper and other metal components.

To avoid damage to the cooling system, make sure to completely flush the cooling system with clear water. Continue to flush the system until all signs of the cleaning agent are gone.

7. Stop the engine and allow the engine to cool. Loosen the cooling system filler cap slowly in order to relieve any pressure. Remove the cooling system filler cap. Open the drain valve or remove the cooling system drain plugs. Allow the coolant to drain. Flush the cooling system with clean water. Close the drain valve. Clean the drain plugs. Install the drain plugs. Refer to Torque Specifications, SENR3130 for more information on the correct torques.

Cooling Systems with Heavy Deposits or Plugging

Note: For the following procedure to be effective, there must be some active flow through the cooling system components.

1. Flush the cooling system with clean water in order to remove any debris.
2. Close the drain valve. Clean the drain plugs. Install the drain plugs. Refer to Torque Specifications, SENR3130 for more information on the correct torques.

NOTICE

Do not fill the cooling system faster than 5 L (1.3 US gal) per minute to avoid air locks.

Cooling system air locks may result in engine damage.

3. Open the vent screw (1) enough to allow the air that is trapped to be purged from the system.
4. Fill the cooling system with a mixture of clean water and Caterpillar Fast Acting Cooling System Cleaner. Add 0.5 L (1 pint) of cleaner per 3.8 to 7.6 L (1 to 2 US gal) of the cooling system capacity.
5. Tighten the vent screw securely. Ensure that the coolant level is 25 mm (0.9843 inch) below filler neck (2) on the header tank or the radiator.

6. Install the cooling system filler cap. Operate the engine without load for approximately 30 minutes, in order to allow circulation. The coolant temperature should be at least 82 °C (180 °F).

NOTICE

Improper or incomplete rinsing of the cooling system can result in damage to copper and other metal components.

To avoid damage to the cooling system, make sure to completely flush the cooling system with clear water. Continue to flush the system until all signs of the cleaning agent are gone.

7. Stop the engine and allow the engine to cool. Loosen the cooling system filler cap slowly in order to relieve any pressure. Remove the cooling system filler cap. Open the drain valve or remove the cooling system drain plugs. Allow the coolant to drain. Flush the cooling system with clean water. Close the drain valve. Clean the drain plugs. Install the drain plugs. Refer to Torque Specifications, SENR3130 for more information on the correct torques.

Fill

1. Open the vent screw (1) enough to allow the air that is trapped to be purged from the system.

NOTICE

Do not fill the cooling system faster than 5 L (1.3 US gal) per minute to avoid air locks.

Cooling system air locks may result in engine damage.

2. Fill the cooling system with the coolant. Refer to this Operation and Maintenance Manual, "Refill Capacities and Recommendations" topic (Maintenance Section) for more information on cooling system specifications.
3. Tighten the vent screw securely. Ensure that the coolant level is 25 mm (0.9843 inch) below filler neck (2) on the header tank or the radiator.
4. Install the cooling system filler cap. Operate the engine without load for approximately 30 minutes, in order to allow circulation. The coolant temperature should be at least 82 °C (180 °F).
5. Stop the engine and allow the engine to cool. Loosen the cooling system filler cap slowly in order to relieve any pressure. Remove the cooling system filler cap. Check the coolant level. If necessary, add coolant to the system.

6. Clean the cooling system filler cap. Inspect the gasket that is on the cooling system filler cap. If the gasket that is on the cooling system filler cap is damaged, discard the old cooling system filler cap and install a new cooling system filler cap. If the gasket that is on the cooling system filler cap is not damaged, perform a pressure test. A 9S-8140 Pressurizing Pump is used to perform the pressure test. The correct pressure for the cooling system filler cap is stamped on the face of the cooling system filler cap. If the cooling system filler cap does not retain the correct pressure, install a new cooling system filler cap.
7. Operate the engine without load. Inspect the cooling system for leaks and for the correct operating temperature.

i03145640

Cooling System Coolant (ELC) - Change

SMCS Code: 1350-070; 1395-044

Clean the cooling system and flush the cooling system before the recommended maintenance interval if the following conditions exist:

- The engine overheats frequently.
- Foaming is observed.
- The oil has entered the cooling system and the coolant is contaminated.
- The fuel has entered the cooling system and the coolant is contaminated.

Note: When the cooling system is cleaned, only clean water is needed when the ELC is drained and replaced.

Note: Inspect the water pump and the water temperature regulator after the cooling system has been drained. This is a good opportunity to replace the water pump, the water temperature regulator and the hoses, if necessary.

Drain

WARNING

Pressurized System: Hot coolant can cause serious burns. To open the cooling system filler cap, stop the engine and wait until the cooling system components are cool. Loosen the cooling system pressure cap slowly in order to relieve the pressure.

Note: The engine can have the ability to auto start. Ensure that the power supply is isolated before any service or repair is performed.

1. Stop the engine and allow the engine to cool. Turn the isolator keyswitch to the OFF position.
2. Loosen the cooling system filler cap slowly in order to relieve any pressure. Remove the cooling system filler cap.
3. Open the cooling system drain valve . If the cooling system is not equipped with a drain valve, remove the cooling system drain plugs.

Note: Drain the engine coolant from the following positions. Rear of engine block, Bottom of the heat exchanger, and the underside of the exhaust manifold. The exhaust manifold may have two drains. The exhaust manifold that is installed on a engine that has a MCS control panel will only have one drain.

Allow the coolant to drain.

NOTICE

Dispose of used engine coolant properly or recycle. Various methods have been proposed to reclaim used coolant for reuse in engine cooling systems. The full distillation procedure is the only method acceptable by Caterpillar to reclaim the used coolant.

For information regarding the disposal and the recycling of used coolant, consult your Caterpillar dealer or consult Dealer Service Tools.

Flush

1. Flush the cooling system with clean water in order to remove any debris.
2. Close the drain valve. Clean the drain plugs. Install the drain plugs. Refer to Torque Specifications, SENR3130 for more information on the correct torques.

NOTICE

Do not fill the cooling system faster than 5 L (1.3 US gal) per minute to avoid air locks.

Cooling system air locks may result in engine damage.

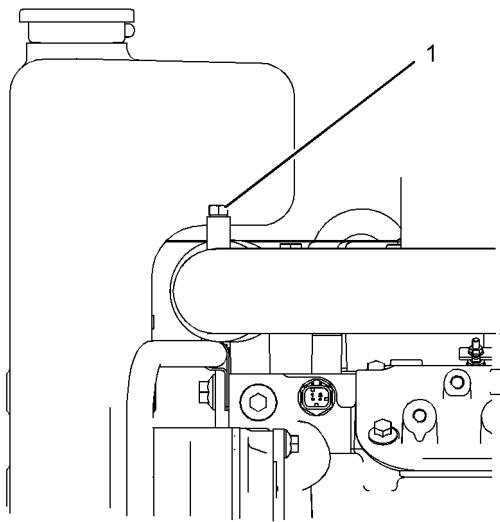


Illustration 84

g01618492

Typical example

3. Open the vent screw (1) enough to allow the air that is trapped to be purged from the system. Fill the cooling system with clean water.

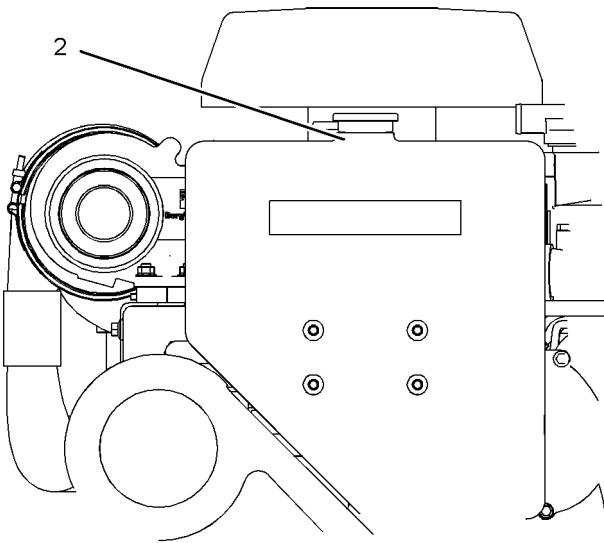


Illustration 85

g01618504

4. Tighten the vent screw securely. Ensure that the coolant level is 25 mm (0.9843 inch) below filler neck (2) on the header tank or the radiator.
5. Install the cooling system filler cap. Operate the engine without load for approximately 30 minutes, in order to allow circulation. The coolant temperature should be at least 82 °C (180 °F).

6. Stop the engine and allow the engine to cool. Loosen the cooling system filler cap slowly in order to relieve any pressure. Remove the cooling system filler cap. Open the drain valve or remove the cooling system drain plugs. Allow the coolant to drain. Flush the cooling system with clean water. Close the drain valve. Clean the drain plugs. Install the drain plugs. Refer to Torque Specifications, SENR3130 for more information on the correct torques.

Fill

NOTICE

Do not fill the cooling system faster than 5 L (1.3 US gal) per minute to avoid air locks.

Cooling system air locks may result in engine damage.

1. Open the vent screw (1) enough to allow the air that is trapped to be purged from the system.
2. Fill the cooling system with Extended Life Coolant (ELC). Refer to this Operation and Maintenance Manual, "Refill Capacities and Recommendations" topic (Maintenance Section) for more information on cooling system specifications.
3. Tighten the vent screw securely. Ensure that the coolant level is 25 mm (0.9843 inch) below filler neck (2) on the header tank or the radiator.
4. Install the cooling system filler cap. Operate the engine without load for approximately 30 minutes, in order to allow circulation. The coolant temperature should be at least 82 °C (180 °F).
5. Stop the engine and allow the engine to cool. Loosen the cooling system filler cap slowly in order to relieve any pressure. Remove the cooling system filler cap. Check the coolant level. If necessary, add coolant to the system.
6. Clean the cooling system filler cap. Inspect the gasket that is on the cooling system filler cap. If the gasket that is on the cooling system filler cap is damaged, discard the old cooling system filler cap and install a new cooling system filler cap. If the gasket that is on the cooling system filler cap is not damaged, perform a pressure test. A 9S-8140 Pressurizing Pump is used to perform the pressure test. The correct pressure for the cooling system filler cap is stamped on the face of the cooling system filler cap. If the cooling system filler cap does not retain the correct pressure, install a new cooling system filler cap.
7. Operate the engine without load. Inspect the cooling system for leaks and for the correct operating temperature.

i03353500

Cooling System Coolant Extender (ELC) - Add

SMCS Code: 1352-045; 1395-081

Cat ELC (Extended Life Coolant) does not require the frequent additions of any supplemental cooling additives which are associated with the present conventional coolants. The Cat ELC Extender only needs to be added once.

NOTICE

Use only Cat Extended Life Coolant (ELC) Extender with Cat ELC.

Do NOT use conventional supplemental coolant additive (SCA) with Cat ELC. Mixing Cat ELC with conventional coolants and/or conventional SCA reduces the Cat ELC service life.

Check the cooling system only when the engine is stopped and cool.



WARNING

Personal injury can result from hot coolant, steam and alkali.

At operating temperature, engine coolant is hot and under pressure. The radiator and all lines to heaters or the engine contain hot coolant or steam. Any contact can cause severe burns.

Remove cooling system pressure cap slowly to relieve pressure only when engine is stopped and cooling system pressure cap is cool enough to touch with your bare hand.

Do not attempt to tighten hose connections when the coolant is hot, the hose can come off causing burns.

Cooling System Coolant Additive contains alkali. Avoid contact with skin and eyes.

NOTICE

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, "Caterpillar Dealer Service Tool Catalog" for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to local regulations and mandates.

Note: The engine can have the ability to auto start. Ensure that the power supply is isolated before any service or repair is performed.

1. Stop the engine and allow the engine to cool. Turn the isolator keyswitch to the OFF position.
2. Loosen the cooling system filler cap slowly in order to relieve pressure. Remove the cooling system filler cap.
3. It may be necessary to drain enough coolant from the cooling system in order to add the Cat ELC Extender.
4. Add Cat ELC Extender according to the requirements for your engine's cooling system capacity. Refer to the Operation and Maintenance Manual, "Refill Capacities and Recommendations" article for more information.
5. Clean the cooling system filler cap. Inspect the gaskets on the cooling system filler cap. Replace the cooling system filler cap if the gaskets are damaged. Install the cooling system filler cap.

i03145688

Cooling System Coolant Level - Check

SMCS Code: 1395-082

Check the coolant level when the engine is stopped and cool.

WARNING

Pressurized System: Hot coolant can cause serious burns. To open the cooling system filler cap, stop the engine and wait until the cooling system components are cool. Loosen the cooling system pressure cap slowly in order to relieve the pressure.

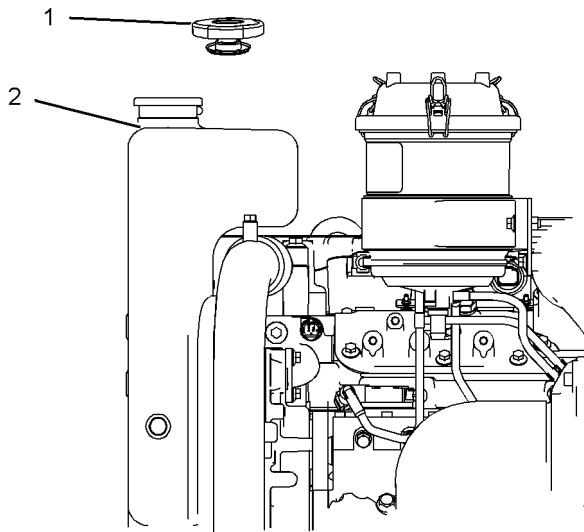


Illustration 86

Typical example

g01618827

Note: The engine can have the ability to auto start. Ensure that the power supply is isolated before any service or repair is performed.

1. Stop the engine and allow the engine to cool. Turn the isolator keyswitch to the OFF position.
2. Remove the cooling system filler cap (1) slowly in order to relieve pressure.
3. Ensure that the coolant level is 25 mm (0.9843 inch) below filler neck (2) on the header tank or the radiator.

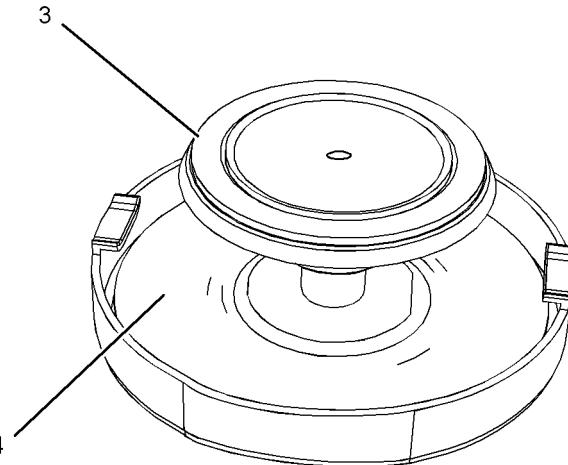


Illustration 87

g01618831

Typical filler cap gaskets

Note: Gasket (4) is not installed on radiator filler caps.

4. Clean the cooling system filler cap and check the condition of the filler cap gaskets (3 and 4). Replace the cooling system filler cap if the filler cap gaskets are damaged. Reinstall the cooling system filler cap.
5. Inspect the cooling system for leaks.

i02837191

Cooling System Coolant Sample (Level 1) - Obtain

SMCS Code: 1350-008; 1395-008; 1395-554; 7542

Note: Obtaining a Coolant Sample (Level 1) is optional if the cooling system is filled with Cat ELC (Extended Life Coolant). Cooling systems that are filled with Cat ELC should have a Coolant Sample (Level 2) that is obtained at the recommended interval that is stated in the Maintenance Interval Schedule.

Note: Obtain a Coolant Sample (Level 1) if the cooling system is filled with any other coolant instead of Cat ELC. This includes the following types of coolants:

- Commercial long life coolants that meet the Caterpillar Engine Coolant Specification -1 (Caterpillar EC-1)
- Cat DEAC (Diesel Engine Antifreeze/Coolant)

Maintenance Section

Cooling System Coolant Sample (Level 2) - Obtain

- Commercial heavy-duty coolant/antifreeze

Table 20

Recommended Interval		
Type of Coolant	Level 1	Level 2
Cat DEAC	Every 250 Hours ⁽¹⁾	Yearly ⁽¹⁾⁽²⁾
Cat ELC	Optional ⁽²⁾	Yearly ⁽²⁾

(1) This is the recommended interval for coolant samples for all conventional heavy-duty coolant/antifreeze. This is also the recommended interval for coolant samples of commercial coolants that meet the Cat EC-1 specification for engine coolant.

(2) The Level 2 Coolant Analysis should be performed sooner if a problem is suspected or identified.

NOTICE

Always use a designated pump for oil sampling, and use a separate designated pump for coolant sampling. Using the same pump for both types of samples may contaminate the samples that are being drawn. This contaminant may cause a false analysis and an incorrect interpretation that could lead to concerns by both dealers and customers.

Note: Level 1 results may indicate a need for Level 2 Analysis.

Obtain the sample of the coolant as close as possible to the recommended sampling interval. In order to receive the full effect of S·O·S analysis, you must establish a consistent trend of data. In order to establish a pertinent history of data, perform consistent samplings that are evenly spaced. Supplies for collecting samples can be obtained from your Caterpillar dealer.

Use the following guidelines for proper sampling of the coolant:

- Complete the information on the label for the sampling bottle before you begin to take the samples.
- Keep the unused sampling bottles stored in plastic bags.
- Obtain coolant samples directly from the coolant sample port. You should not obtain the samples from any other location.
- Keep the lids on empty sampling bottles until you are ready to collect the sample.
- Place the sample in the mailing tube immediately after obtaining the sample in order to avoid contamination.
- Never collect samples from expansion bottles.

- Never collect samples from the drain for a system.

Submit the sample for Level 1 analysis.

For additional information about coolant analysis, see this Operation and Maintenance Manual, "Refill Capacities and Recommendations" or consult your Caterpillar dealer.

i01987714

Cooling System Coolant Sample (Level 2) - Obtain

SMCS Code: 1350-008; 1395-008; 1395-554; 7542

NOTICE

Always use a designated pump for oil sampling, and use a separate designated pump for coolant sampling. Using the same pump for both types of samples may contaminate the samples that are being drawn. This contaminant may cause a false analysis and an incorrect interpretation that could lead to concerns by both dealers and customers.

Refer to Operation and Maintenance Manual, "Cooling System Coolant Sample (Level 1) - Obtain" for the guidelines for proper sampling of the coolant.

Submit the sample for Level 2 analysis.

For additional information about coolant analysis, see Special Publication, SEBU6251, "Caterpillar Commercial Diesel Engines Fluids Recommendations" or consult your Caterpillar dealer.

i02017557

Cooling System Supplemental Coolant Additive (SCA) - Test/Add

SMCS Code: 1352-045; 1395-081

WARNING

Cooling system coolant additive contains alkali. To help prevent personal injury, avoid contact with the skin and eyes. Do not drink cooling system coolant additive.

Note: Caterpillar recommends an S·O·S coolant analysis (Level 1).

Test the Concentration of the SCA

Coolant/Antifreeze and SCA

NOTICE

Do not exceed the recommended six percent supplemental coolant additive concentration.

Test the concentration of the SCA with the 8T-5296 Coolant Conditioner Test Kit. Follow the instructions that are provided in the kit.

Water and SCA

NOTICE

Do not exceed the recommended eight percent supplemental coolant additive concentration.

Test the concentration of the SCA with the 8T-5296 Coolant Conditioner Test Kit. Use the instructions that follow:

1. Fill the syringe to the "1.0 ml" mark with the coolant.
2. Dispense the 1.0 mL coolant sample from the syringe into the empty mixing bottle.
3. Add tap water to the mixing bottle in order to bring the level up to the "10 ml" mark. Place the cap on the bottle and shake the bottle.
4. Add 2 to 3 drops of the "NITRITE INDICATOR SOLUTION B" to the mixing bottle. Move the bottle in a circular motion in order to mix the solution.
5. Add 1 drop of "NITRITE TEST SOLUTION A" to the mixing bottle. Move the bottle in a circular motion in order to mix the solution.
6. Repeat 5 until the solution changes color from red to light gray, green, or blue. Record the number of drops of "NITRITE TEST SOLUTION A" that were required to cause the color change.
7. Use Table 21 to interpret the results.

Table 21

Number of Drops	Concentration of SCA	Maintenance Required
Less than 25	Less than the recommended concentration of SCA	Add SCA. Retest the coolant.
25 to 30	The recommended concentration of SCA	None
More than 30	More than the recommended concentration of SCA	Remove the coolant. Replace with water only. Retest the coolant.

Add the SCA, If Necessary

⚠ WARNING

Pressurized System: Hot coolant can cause serious burns. To open the cooling system filler cap, stop the engine and wait until the cooling system components are cool. Loosen the cooling system pressure cap slowly in order to relieve the pressure.

1. Remove the cooling system filler cap slowly.

Note: Always dispose of fluids according to local regulations.

2. If necessary, drain some coolant in order to allow space for the addition of the SCA.

NOTICE

Excessive supplemental coolant additive concentration can form deposits on the higher temperature surfaces of the cooling system, reducing the engine's heat transfer characteristics. Reduced heat transfer could cause cracking of the cylinder head and other high temperature components.

Excessive supplemental coolant additive concentration could also result in blockage of the heat exchanger, overheating, and/or accelerated wear of the water pump seal.

Do not exceed the recommended amount of supplemental coolant additive concentration.

3. Add the proper amount of SCA. The concentration of the SCA depends on the type of coolant that is used. To determine the proper amount, see this Operation and Maintenance Manual, "Refill Capacities and Recommendations" topic.

4. Clean the cooling system filler cap. Install the cooling system filler cap.

i02623972

Cooling System Water Temperature Regulator - Replace

SMCS Code: 1355-510

Replace the water temperature regulator before the water temperature regulator fails. This is a recommended preventive maintenance practice. Replacing the water temperature regulator reduces the chances for unscheduled downtime.

A water temperature regulator that fails in a partially opened position can cause overheating or overcooling of the engine.

A water temperature regulator that fails in the closed position can cause excessive overheating. Excessive overheating could result in cracking of the cylinder head or piston seizure problems.

A water temperature regulator that fails in the open position will cause the engine operating temperature to be too low during partial load operation. Low engine operating temperatures during partial loads could cause an excessive carbon buildup inside the cylinders. This excessive carbon buildup could result in an accelerated wear of the piston rings and wear of the cylinder liner.

NOTICE

Failure to replace your water temperature regulator on a regularly scheduled basis could cause severe engine damage.

Caterpillar engines incorporate a shunt design cooling system and require operating the engine with a water temperature regulator installed.

If the water temperature regulator is installed incorrectly, the engine may overheat, causing cylinder head damage. Ensure that the new water temperature regulator is installed in the original position. Ensure that the water temperature regulator vent hole is open.

Do not use liquid gasket material on the gasket or cylinder head surface.

Refer to two articles in the Disassembly and Assembly Manual, "Water Temperature Regulators - Remove and Water Temperature Regulators - Install" for the replacement procedure of the water temperature regulator, or consult your Caterpillar dealer.

Note: If only the water temperature regulators are replaced, drain the coolant from the cooling system to a level that is below the water temperature regulator housing.

i01595880

Electrical Connections - Check

SMCS Code: 4459-535

Check all exposed electrical connections for tightness.

Check the following devices for loose mounting or for physical damage:

- transformers
- fuses
- capacitors
- lightning arrestors

Check all lead wires and electrical connections for proper clearance.

i01664717

Engine - Clean

SMCS Code: 1000-070

⚠ WARNING

Personal injury or death can result from high voltage.

Moisture could create paths of electrical conductivity.

Make sure the unit is off line (disconnected from utility and/or other generators), locked out and tagged "Do Not Operate".

NOTICE

Water or condensation can cause damage to generator components. Protect all electrical components from exposure to water.

NOTICE

Accumulated grease and oil on an engine is a fire hazard. Keep the engine clean. Remove debris and fluid spills whenever a significant quantity accumulates on the engine.

Steam cleaning the engine will remove accumulated oil and grease. A clean engine provides the following benefits:

- Easy detection of fluid leaks
- Maximum heat transfer characteristics
- Ease of maintenance

Note: For more information on cleaning and drying electric generators, refer to Special Instruction, SEHS9124, "Cleaning and Drying of Electric Set Generators".

i03077941

Engine Air Cleaner Element - Clean/Replace

SMCS Code: 1054-070; 1054-510

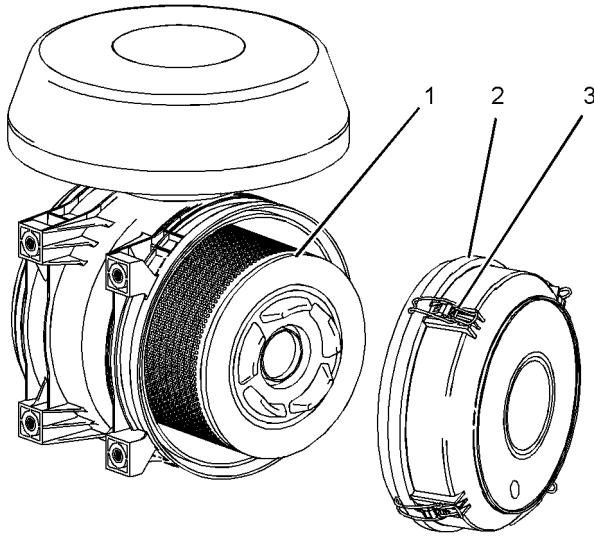


Illustration 88

g01560871

Typical example

Note: The engine can have the ability to auto start. Ensure that the power supply is isolated before any service or repair is performed.

1. Release the clips (3) and remove the cover (2).
2. Remove the element (1) and discard the element.
3. Ensure that all parts are clean and free from dirt. Install a new element.
4. Align the cover to the body of the air cleaner. Ensure that the cover is oriented correctly and install the cover.

i02335405

Engine Air Cleaner Service Indicator - Inspect

SMCS Code: 7452-040

Some engines may be equipped with a different service indicator.

Some engines are equipped with a differential gauge for inlet air pressure. The differential gauge for inlet air pressure displays the difference in the pressure that is measured before the air cleaner element and the pressure that is measured after the air cleaner element. As the air cleaner element becomes dirty, the pressure differential rises. If your engine is equipped with a different type of service indicator, follow the OEM recommendations in order to service the air cleaner service indicator.

The service indicator may be mounted on the air cleaner element or in a remote location.

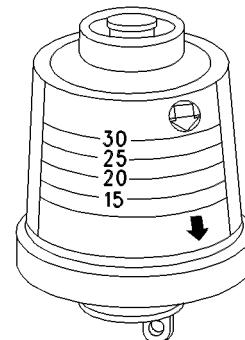


Illustration 89

g00103777

Typical service indicator

Observe the service indicator. The air cleaner element should be cleaned or the air cleaner element should be replaced when one of the following conditions occur:

- The yellow diaphragm enters the red zone.
- The red piston locks in the visible position.

Test the Service Indicator

Service indicators are important instruments.

- Check for ease of resetting. The service indicator should reset in less than three pushes.
- Check the movement of the yellow core when the engine is accelerated to the engine rated speed. The yellow core should latch at the greatest vacuum that is attained.

If the service indicator does not reset easily, or if the yellow core does not latch at the greatest vacuum, the service indicator should be replaced. If the new service indicator will not reset, the hole for the service indicator may be restricted.

The service indicator may need to be replaced frequently in environments that are severely dusty.

i03436263

Engine Crankcase Breather - Replace

SMCS Code: 1317-510

NOTICE

Perform this maintenance with the engine stopped.

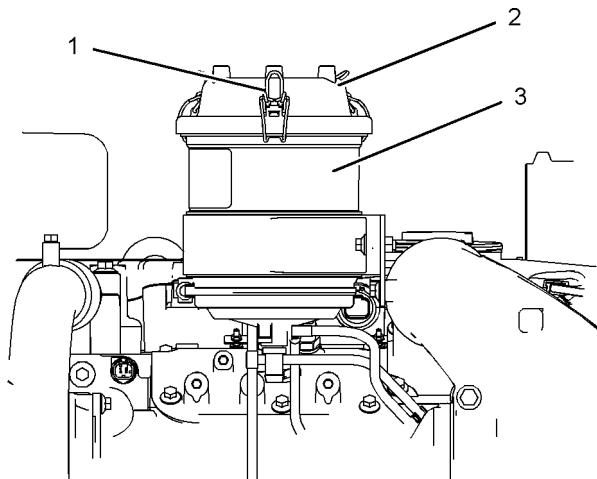


Illustration 90

g01561033

Typical example

Note: The engine can have the ability to auto start. Ensure that the power supply is isolated before any service or repair is performed.

Remove all dirt and oil from the outside of the breather assembly.

1. Release the clips (1) and remove the cover (2). Remove the old element.
2. Ensure that the inner body of the breather body (3) is clean.

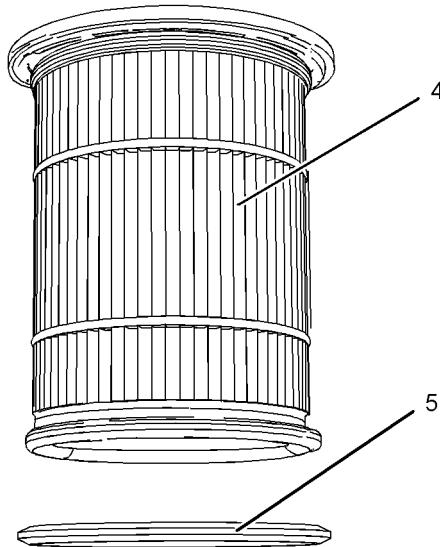


Illustration 91

g01618932

Typical example

3. Ensure that the O ring seal (5) is located correctly.
4. Install the new element (4) into the breather body (3). Align the cover (2) to the breather body and install the cover.

i02456872

Engine Mounts - Inspect

SMCS Code: 1152-040

Inspect the engine mounts for deterioration and for proper bolt torque. Engine vibration can be caused by the following conditions:

- Improper mounting of the engine
- Deterioration of the engine mounts

Any engine mount that shows deterioration should be replaced. Refer to Special Publication, SENR3130, "Torque Specifications" for the recommended torques. Refer to the OEM recommendations for more information.

i03353861

i01935337

Engine Oil Level - Check

SMCS Code: 1348-535-FLV

⚠ WARNING

Hot oil and hot components can cause personal injury. Do not allow hot oil or hot components to contact the skin.

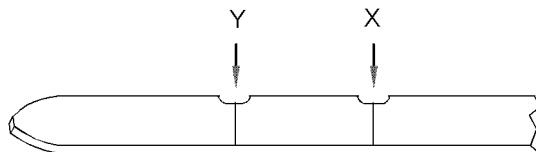


Illustration 92

g01165836

(Y) "Min" mark. (X) "Max" mark.

NOTICE

Perform this maintenance with the engine stopped.

Note: Ensure that the engine is either level or that the engine is in the normal operating position in order to obtain a true level indication.

Note: After the engine has been switched OFF, wait for ten minutes in order to allow the engine oil to drain to the oil pan before checking the oil level.

Note: The engine can have the ability to auto start. Ensure that the power supply is isolated before any service or repair is performed.

- Maintain the oil level between the "ADD" mark (Y) and the "FULL" mark (X) on the engine oil dipstick. Do not fill the crankcase above the "FULL" mark (X).

NOTICE

Operating your engine when the oil level is above the "FULL" mark could cause your crankshaft to dip into the oil. The air bubbles created from the crankshaft dipping into the oil reduces the oil's lubricating characteristics and could result in the loss of power.

- Remove the oil filler cap and add oil, if necessary. Clean the oil filler cap. Install the oil filler cap.

Engine Oil Sample - Obtain

SMCS Code: 1000-008; 1348-554-SM;
7542-554-OC, SM

In addition to a good preventive maintenance program, Caterpillar recommends using S·O·S oil analysis at regularly scheduled intervals in order to monitor the condition of the engine and the maintenance requirements of the engine. S·O·S oil analysis provides infrared analysis, which is required for determining nitration and oxidation levels.

Obtain the Sample and the Analysis

⚠ WARNING

Hot oil and hot components can cause personal injury. Do not allow hot oil or hot components to contact the skin.

Before you take the oil sample, complete the Label, PEEP5031 for identification of the sample. In order to help obtain the most accurate analysis, provide the following information:

- Engine model
- Service hours on the engine
- The number of hours that have accumulated since the last oil change
- The amount of oil that has been added since the last oil change

To ensure that the sample is representative of the oil in the crankcase, obtain a warm, well mixed oil sample.

To avoid contamination of the oil samples, the tools and the supplies that are used for obtaining oil samples must be clean.

Caterpillar recommends using the sampling valve in order to obtain oil samples. The quality and the consistency of the samples are better when the sampling valve is used. The location of the sampling valve allows oil that is flowing under pressure to be obtained during normal engine operation.

The 169-8373 Fluid Sampling Bottle is recommended for use with the sampling valve. The fluid sampling bottle includes the parts that are needed for obtaining oil samples. Instructions are also provided.

NOTICE

Always use a designated pump for oil sampling, and use a separate designated pump for coolant sampling. Using the same pump for both types of samples may contaminate the samples that are being drawn. This contamination may cause a false analysis and an incorrect interpretation that could lead to concerns by both dealers and customers.

If the engine is not equipped with a sampling valve, use the 1U-5718 Vacuum Pump. The pump is designed to accept sampling bottles. Disposable tubing must be attached to the pump for insertion into the sump.

For instructions, see Special Publication, PEHP6001, "How To Take A Good Oil Sample". Consult your Caterpillar dealer for complete information and assistance in establishing an S·O·S program for your engine.

i03078440

Engine Oil and Filter - Change (Single Oil Filter)

SMCS Code: 1318-510; 1348-044

WARNING

Hot oil and hot components can cause personal injury. Do not allow hot oil or hot components to contact the skin.

NOTICE

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Dispose of all fluids according to local regulations and mandates.

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

Ensure that all adjustments, maintenance and repairs are performed by authorized personnel that have had the correct training.

Do not drain the engine lubricating oil when the engine is cold. As the engine lubricating oil cools, suspended waste particles settle on the bottom of the oil pan. The waste particles are not removed with draining cold oil. Drain the oil pan with the engine stopped. Drain the oil pan with the oil warm. This draining method allows the waste particles that are suspended in the oil to be drained properly.

Failure to follow this recommended procedure will cause the waste particles to be recirculated through the engine lubrication system with the new oil.

Drain the Engine Lubricating Oil

Ensure that the vessel that will be used is large enough to collect the waste oil.

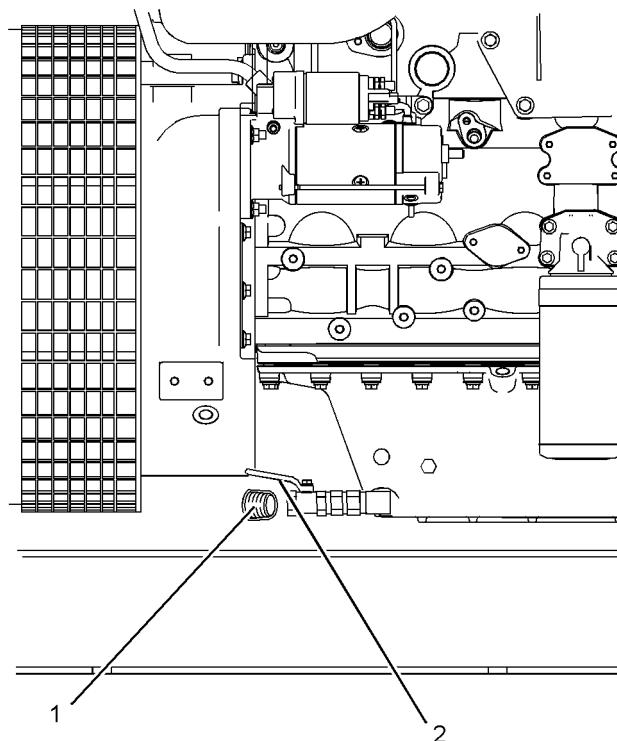


Illustration 93

g01561243

Typical example

1. The engine can have the ability to auto start. Ensure that the power supply is isolated before any service or repair is performed.
2. Remove drain plug (1). Install drain line to the connection.
3. Open drain valve (2). Allow the engine oil to drain. After the oil has drained, close the drain valve.
4. Remove drain line and install a new drain plug. Tighten the drain plug securely.

Note: Some application may have a pump in order to remove the engine oil. Connect a drain line to the pump. Unlock the pump and operate the pump in order to remove the engine oil. After the oil has been removed, lock the pump and remove the drain line.

Single Oil Filter

Note: Change the oil filter with the engine stopped.

Caterpillar oil filters are manufactured to Caterpillar specifications. Use of an oil filter that is not recommended by Caterpillar could result in severe damage to the engine bearings, and the crankshaft. This is a result of the larger waste particles from unfiltered oil that can enter the engine lubricating system. Only use oil filters that are recommended by Caterpillar.

1. Clear the area around the oil filter.
2. Remove the oil filter with a 1U-8760 Chain Wrench.

Note: The following actions can be carried out as part of the preventive maintenance program.

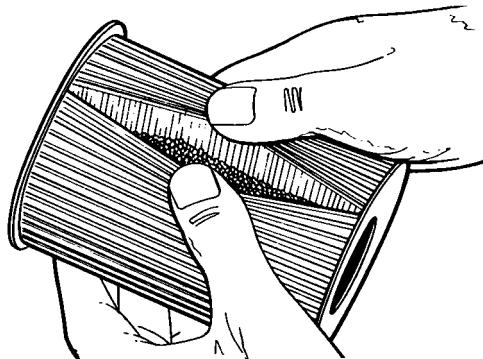


Illustration 94

Element with debris

g00588944

3. Cut the oil filter open with a 175-7546 Oil Filter Cutter. Break apart the pleats and inspect the oil filter for metal debris. An excessive amount of metal debris in the oil filter may indicate early wear or a pending failure.

Use a magnet to differentiate between the ferrous metals and the nonferrous metals that are found in the oil filter element. Ferrous metals may indicate wear on the steel and cast iron parts of the engine.

Nonferrous metals may indicate wear on the aluminum parts, brass parts or bronze parts of the engine. Parts that may be affected include the following items: main bearings, rod bearings, turbocharger bearings, and cylinder heads.

Due to normal wear and friction, it is not uncommon to find small amounts of debris in the oil filter. Consult your Caterpillar dealer in order to arrange for a further analysis if an excessive amount of debris is found in the oil filter.

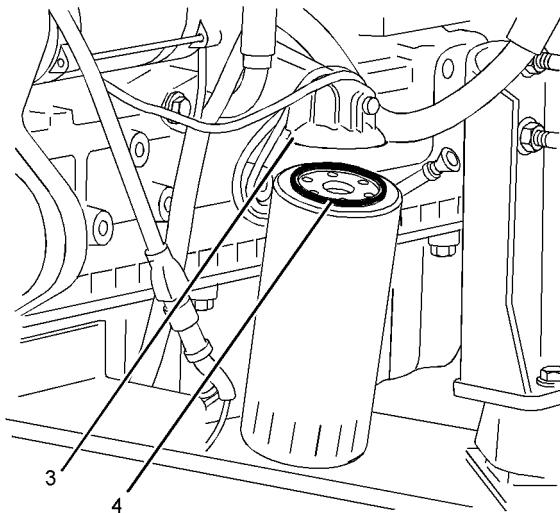


Illustration 95

g01561654

4. Clean the sealing surface of the oil filter base (3).
5. Apply clean engine oil to the O ring seal (4) for the new oil filter.

NOTICE

Do not fill the oil filters with oil before installing them. This oil would not be filtered and could be contaminated. Contaminated oil can cause accelerated wear to engine components.

6. Install the engine oil filter. Spin on the oil filter until the O ring seal contacts the oil filter base. Rotate the oil filter $\frac{3}{4}$ of a full turn.

Fill the Oil Pan

1. Remove the oil filler cap. Refer to this Operation and Maintenance Manual, "Fluid Recommendations" for more information on suitable oils. Fill the oil pan with the correct amount of new engine lubricating oil. Refer to this Operation and Maintenance Manual, "Refill Capacities" for more information on refill capacities.
2. Start the engine and operate the engine at "no load" for two minutes. Perform this procedure in order to ensure that the lubrication system has oil and that the oil filters are filled. Inspect the oil filter for oil leaks.

3. Stop the engine and allow the oil to drain back to the oil pan for a minimum of ten minutes.

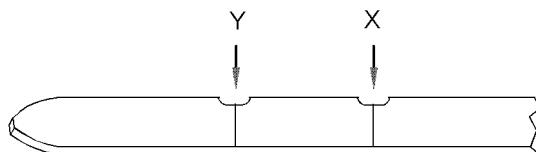


Illustration 96

g01165836

Typical example

4. Remove the engine oil level gauge in order to check the oil level. Maintain the oil level between the "MIN" and "MAX" marks on the engine oil level gauge.

i03197705

Engine Oil and Filter - Change (Duplex Oil filters)

SMCS Code: 1318-510; 1348-044

Replace Engine Oil

WARNING

Hot oil and hot components can cause personal injury. Do not allow hot oil or hot components to contact the skin.

NOTICE

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Dispose of all fluids according to local regulations and mandates.

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

Do not drain the engine lubricating oil when the engine is cold. As the engine lubricating oil cools, suspended waste particles settle on the bottom of the oil pan. The waste particles are not removed with draining cold oil. Drain the oil pan with the engine stopped. Drain the oil pan with the oil warm. This draining method allows the waste particles that are suspended in the oil to be drained properly.

Ensure that all adjustments, maintenance and repairs are performed by authorized personnel that have the correct training.

Ensure that the vessel that will be used is large enough to collect the waste oil.

Failure to follow this recommended procedure will cause the waste particles to be recirculated through the engine lubrication system with the new oil.

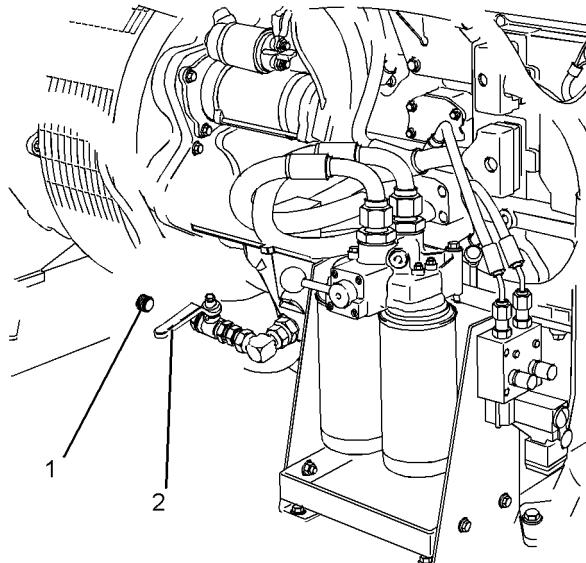


Illustration 97

g01630673

Typical example

1. The engine can have the ability to auto start. Ensure that the power supply is isolated before any service or repair is performed.
2. Remove drain plug (1). Install drain line to the connection.
3. Open drain valve (2). Allow the engine oil to drain. After the oil has drained, close the drain valve.
4. Remove drain line and install a new drain plug. Tighten the drain plug securely.

Note: Some application may have a pump in order to remove the engine oil. Connect a drain line to the pump. Unlock the pump and operate the pump in order to remove the engine oil. After the oil has been removed, lock the pump and remove the drain line.

Fill the Oil Pan

1. Remove the oil filler cap. Refer to the Operation and Maintenance Manual, "Fluid Recommendations" for more information on suitable oils. Fill the oil pan with the correct amount of new engine lubricating oil. Refer to this Operation and Maintenance Manual, "Refill Capacities" for more information on refill capacities.
2. Refer to "Commissioning Procedure for Duplex Oil Filters" before the engine is started.
3. Start the engine and operate the engine at "no load" for two minutes. Perform this procedure in order to ensure that the lubrication system has oil and that the oil filters are filled. Inspect the oil filter for oil leaks.
4. Stop the engine and allow the oil to drain back to the oil pan for a minimum of ten minutes.

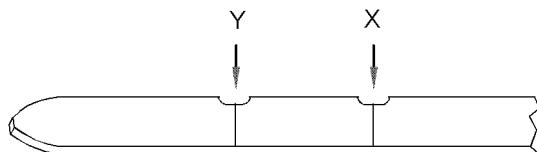


Illustration 98

g01165836

Typical example

5. Remove the engine oil level gauge in order to check the oil level. Maintain the oil level between the "MIN" and "MAX" marks on the engine oil level gauge.

Commissioning Procedure for Duplex Oil Filters

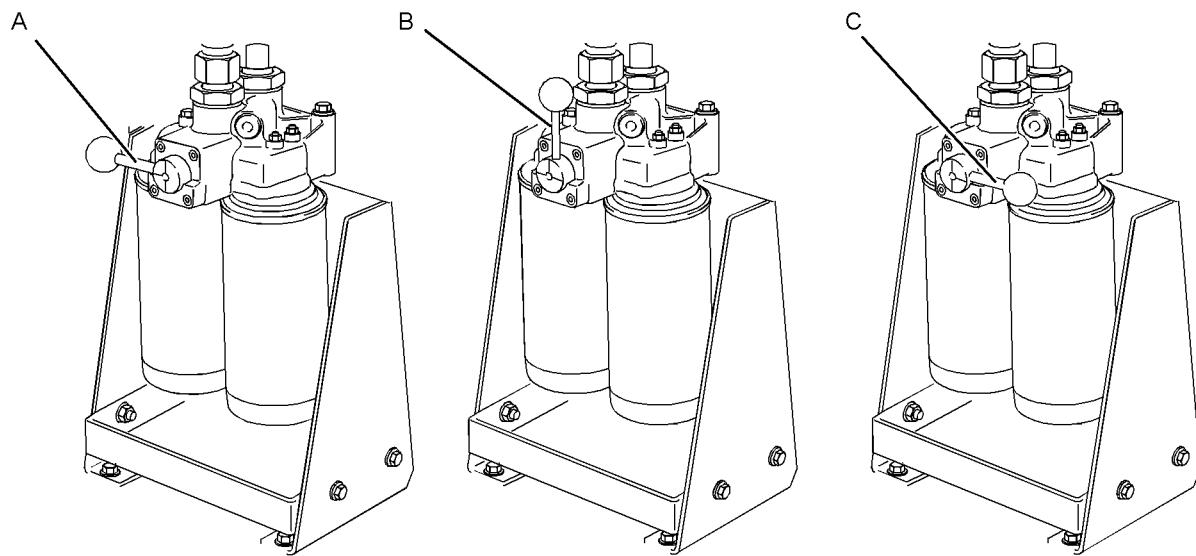


Illustration 99

Typical example

g01628874

- (A) The oil flow is to the left hand oil filter.
- (B) The oil flow is to both oil filters.
- (C) The oil flow is to the right hand oil filter.

1. The engine can have the ability to auto start. Ensure that the power supply is isolated before any service or repair is performed.

3. Install the engine oil filters. Spin on the oil filter until the O ring seal contacts the oil filter base. Rotate the oil filter $\frac{3}{4}$ of a full turn.
4. Ensure that the control lever is in position B. Refer to illustration 99.
5. Ensure that the engine has the correct amount of clean engine lubricating oil. Refer to "Replace Engine Oil" for more information.
6. Operate the engine with no load in order to fill both oil filters.
7. Check the engine oil pressure. Stop the engine and allow time for the engine oil to drain into the oil pan. Check the engine oil, refer to the Operation and Maintenance Manual, "Engine Oil Level - Check".
8. Rotate the lever in the direction of the oil filter that is intended to be used and operate the engine.

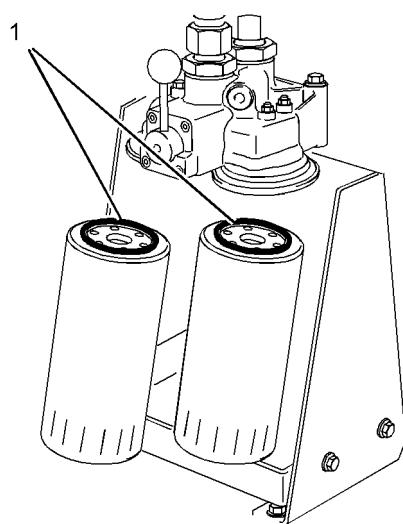


Illustration 100

g01633096

2. Apply clean engine oil to both O ring seals (1) for the new oil filters.

Replacement of Duplex Filter with the Engine in Operation

An engine can be operated during the replacement of the filters, provided that duplex filters are installed.

Note: With the control lever in position A, the flow of oil is to the left hand oil filter. With the control lever in position C, the flow of oil is to the right hand oil filter. Refer to illustration 99.

- Clean the area around the oil filters.

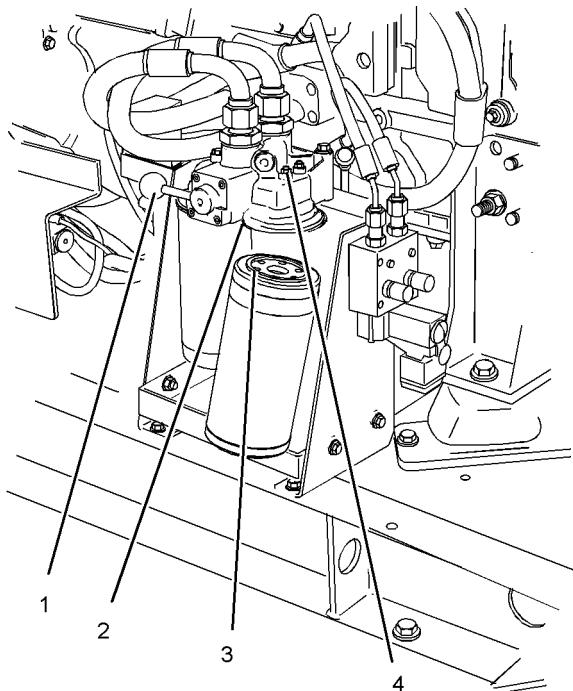


Illustration 101

g01633235

The control lever is in position A. The right hand oil filter has been isolated from the oil flow.

- Rotate the control lever (1) slowly in the direction of the oil filter that is intended to be used. Allow time for the oil filter to fill and check for leaks on the oil filter. Check that the engine oil pressure is correct.
- Place a soft cloth over the vent screw (4) and open the vent screw . This will allow any pressure that is in the isolated oil filter to be released.
- Tighten the vent screw securely.
- Remove the oil filter with a 1U-8760 Chain Wrench.

Note: The following actions can be carried out as part of the preventive maintenance program.

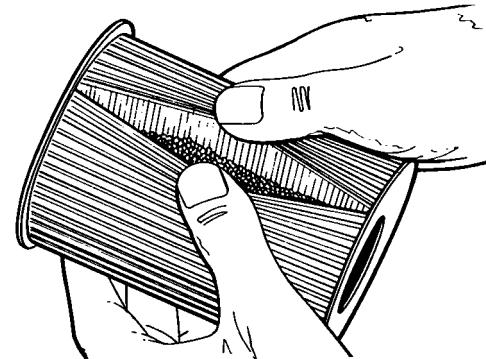


Illustration 102

g00588944

Element with debris

- Cut the oil filter open with a 175-7546 Oil Filter Cutter. Break apart the pleats and inspect the oil filter for metal debris. An excessive amount of metal debris in the oil filter may indicate early wear or a pending failure.

Use a magnet to differentiate between the ferrous metals and the nonferrous metals that are found in the oil filter element. Ferrous metals may indicate wear on the steel and cast iron parts of the engine.

Nonferrous metals may indicate wear on the aluminum parts, brass parts or bronze parts of the engine. Parts that may be affected include the following items: main bearings, rod bearings, turbocharger bearings, and cylinder heads.

Due to normal wear and friction, it is not uncommon to find small amounts of debris in the oil filter. Consult your Caterpillar dealer in order to arrange for a further analysis if an excessive amount of debris is found in the oil filter.

- Clean the sealing surface of the oil filter base (2).
- Apply clean engine oil to the O ring seal (3) for the new oil filter.

NOTICE

Do not fill the oil filters with oil before installing them. This oil would not be filtered and could be contaminated. Contaminated oil can cause accelerated wear to engine components.

- Install the engine oil filter. Spin on the oil filter until the O ring seal contacts the oil filter base. Rotate the oil filter $\frac{3}{4}$ of a full turn.
- Drain the tray below the filter.

i02861779

Engine Protective Devices - Check

SMCS Code: 7400-535

Visual Inspection

Visually check the condition of all gauges, sensors and wiring. Look for wiring and components that are loose, broken, or damaged. Damaged wiring or components should be repaired or replaced immediately.

Calibration Check

NOTICE

During testing, abnormal operating conditions must be simulated.

The tests must be performed correctly in order to prevent possible damage to the engine.

Alarms and shutoffs must function properly. Alarms provide timely warning to the operator. Shutoffs help to prevent damage to the engine. It is impossible to determine if the engine protective devices are in good working order during normal operation. Malfunctions must be simulated in order to test the engine protective devices. To prevent damage to the engine, only authorized service personnel or your Caterpillar dealer should perform the tests.

Consult your Caterpillar dealer or refer to the Service Manual for more information.

i02519453

Engine Valve Lash - Inspect/Adjust

SMCS Code: 1102-025

This maintenance is recommended by Caterpillar as part of a lubrication and preventive maintenance schedule in order to help provide maximum engine life.

NOTICE

Only qualified service personnel should perform this maintenance. Refer to the Service Manual or your Caterpillar dealer for the complete valve lash adjustment procedure.

Operation of Caterpillar engines with improper valve adjustments can reduce engine efficiency. This reduced efficiency could result in excessive fuel usage and/or shortened engine component life.

WARNING

Ensure that the engine can not be started while this maintenance is being performed. To help prevent possible injury, do not use the starting motor to turn the flywheel.

Hot engine components can cause burns. Allow additional time for the engine to cool before measuring/adjusting valve lash clearance.

Ensure that the engine is stopped before measuring the valve lash. To obtain an accurate measurement, allow the valves to cool before this maintenance is performed.

Refer to the Service Manual for more information.

i03080761

Fuel System - Prime (Single Fuel Filter Assembly)

SMCS Code: 1258-548

WARNING

Contact with high pressure fuel may cause fluid penetration and burn hazards. High pressure fuel spray may cause a fire hazard. Failure to follow these inspection, maintenance and service instructions may cause personal injury or death.

Refer to the Operation and Maintenance Manual , "General Hazard Information and High Pressure Fuel Lines" before adjustments and repairs are performed.

Note: Refer to Testing and Adjusting Manual , "Cleanliness of Fuel System Components" for detailed information on the standards of cleanliness that must be observed during ALL work on the fuel system.

Ensure that all adjustments, maintenance and repairs are performed by authorized personnel that have had the correct training.

NOTICE

Do not crank the engine continuously for more than 30 seconds. Allow the starting motor to cool for two minutes before cranking the engine again.

If air enters the fuel system, the air must be purged from the fuel system before the engine can be started. Air can enter the fuel system when the following events occur:

- The fuel tank is empty or the fuel tank has been partially drained.
- The low pressure fuel lines are disconnected.
- A leak exists in the low pressure fuel system.
- The fuel filter has been replaced.

Priming a Single Filter System

Use the following procedures in order to remove air from the fuel system:

1. The engine can have the ability to auto start. Ensure that the power supply is isolated before any service or repair is performed.
2. Ensure that the fuel system is in working order. Check that the fuel supply valve (if equipped) is in the "ON" position.

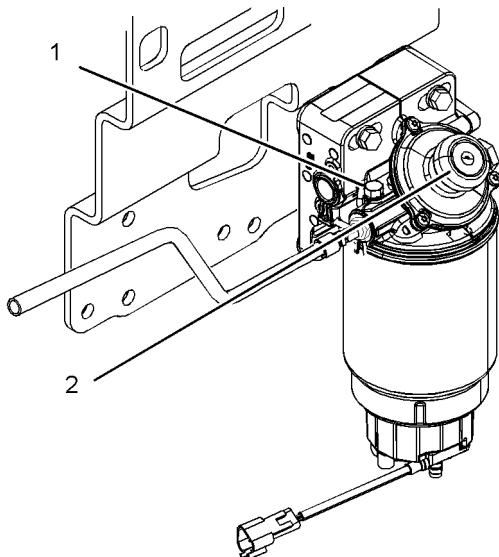


Illustration 103

g01619777

Typical example

3. Loosen the vent screw (1). Operate the fuel priming pump (2). Operate the pump until all the air is removed from the filter.

4. Tighten the vent screw to a torque of 6 N·m (4 lb ft).
5. Operate the fuel priming pump (1) until a strong pressure is felt on the fuel priming pump.
6. Operate the engine starter and crank the engine. After the engine has started, operate the engine for five minutes without load, immediately after air has been removed from the fuel system.

Note: Operating the engine for this period of time will help ensure that the fuel system is free of air.

Do not loosen the high pressure fuel line in order to purge air from the fuel system. This procedure is not required.

After the engine has stopped, you must wait for 60 seconds in order to allow the fuel pressure to be purged from the high pressure fuel lines before any service or repair is performed on the engine fuel lines. If necessary, perform minor adjustments.

Repair any leaks from the low pressure fuel system and from the cooling, lubrication or air systems. Replace any high pressure fuel line that has leaked. Refer to Disassembly and assembly Manual, "Fuel Injection Lines - Install".

If you inspect the engine in operation, always use the proper inspection procedure in order to avoid a fluid penetration hazard. Refer to Operation and Maintenance Manual, "General hazard Information".

7. If you have ensured that the air has been removed from the fuel system and the engine fails to start refer to Troubleshooting, "Engine Cranks but Will Not Start".

i03194303

Fuel System - Prime (Duplex Fuel Filter)

SMCS Code: 1258-548

WARNING

Contact with high pressure fuel may cause fluid penetration and burn hazards. High pressure fuel spray may cause a fire hazard. Failure to follow these inspection, maintenance and service instructions may cause personal injury or death.

Refer to the Operation and Maintenance Manual , "General Hazard Information and High Pressure Fuel Lines" before adjustments and repairs are performed.

Note: Refer to Testing and Adjusting Manual , "Cleanliness of Fuel System Components" for detailed information on the standards of cleanliness that must be observed during ALL work on the fuel system.

Ensure that all adjustments, maintenance and repairs are performed by authorized personnel that have had the correct training.

NOTICE

Do not crank the engine continuously for more than 30 seconds. Allow the starting motor to cool for two minutes before cranking the engine again.

If air enters the fuel system, the air must be purged from the fuel system before the engine can be started. Air can enter the fuel system when the following events occur:

- The fuel tank is empty or the fuel tank has been partially drained.
- The low pressure fuel lines are disconnected.
- A leak exists in the low pressure fuel system.
- The fuel filter has been replaced.

Priming the Duplex Fuel Filters with the Engine Stopped

Note: The engine can have the ability to auto start. Ensure that the power supply is isolated before any service or repair is performed.

Use the following procedures in order to remove air from the fuel system:

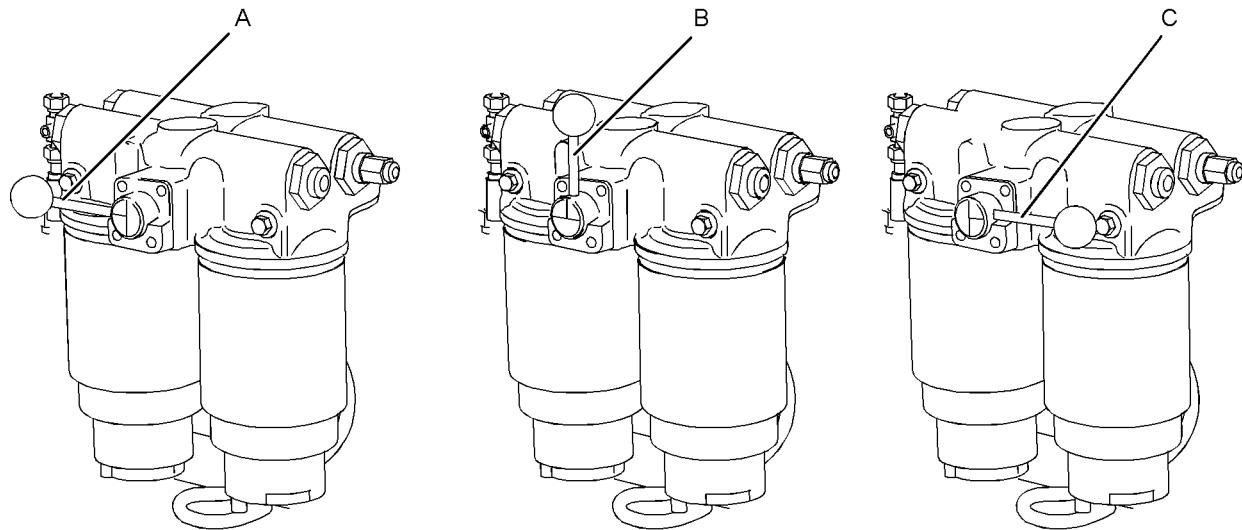


Illustration 104

g01627770

Typical example

- (A) The fuel flow is to the left hand fuel filter.
- (B) The fuel flow is to both fuel filters.
- (C) The fuel flow is to the right hand fuel filter.

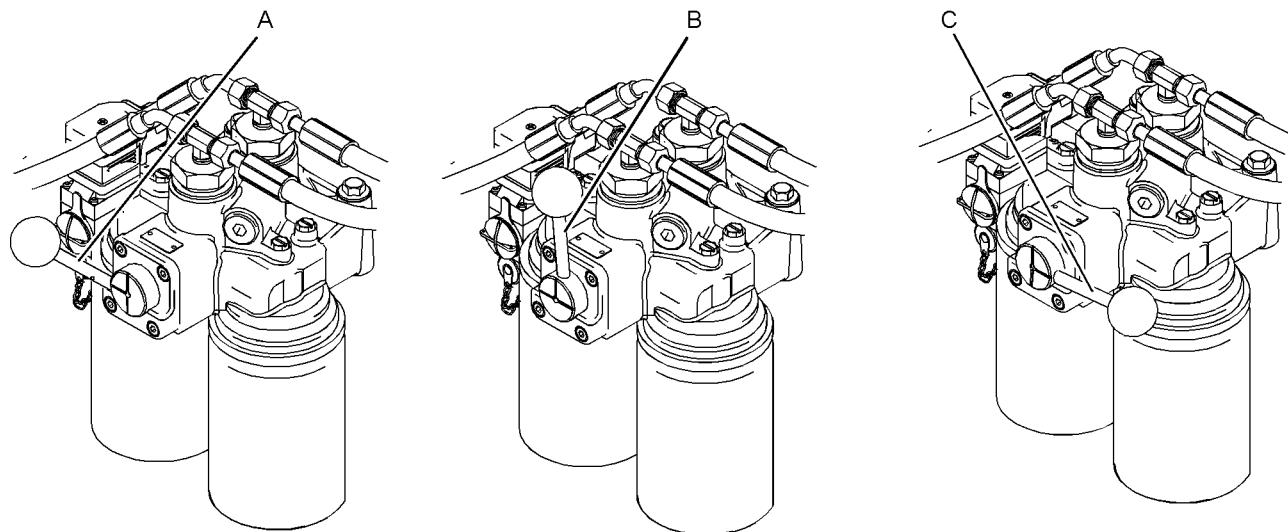


Illustration 105

g01628110

Typical example

- (A) The fuel flow is to the left hand fuel filter.
- (B) The fuel flow is to both fuel filters.
- (C) The fuel flow is to the right hand fuel filter.

Commissioning procedure

Use the following procedure in order to remove air from both fuel filters.

Duplex Fuel Filters

- The engine can have the ability to auto start. Ensure that the power supply is isolated before any service or repair is performed.

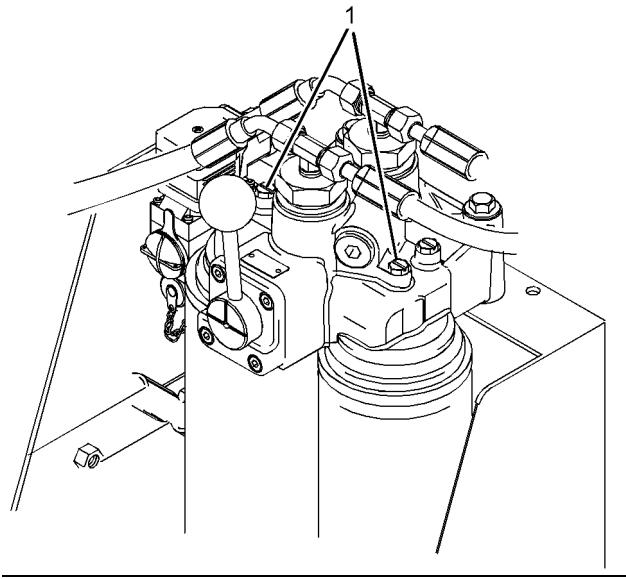


Illustration 106

Secondary fuel filters

g01634603

- Ensure that the fuel system is in working order. Check that the fuel supply valve (if equipped) is in the "ON" position.
- Ensure that the control levers are in position B. Refer to illustration 104 and illustration 105.
- Loosen the vent screws (1) on the secondary fuel filter.

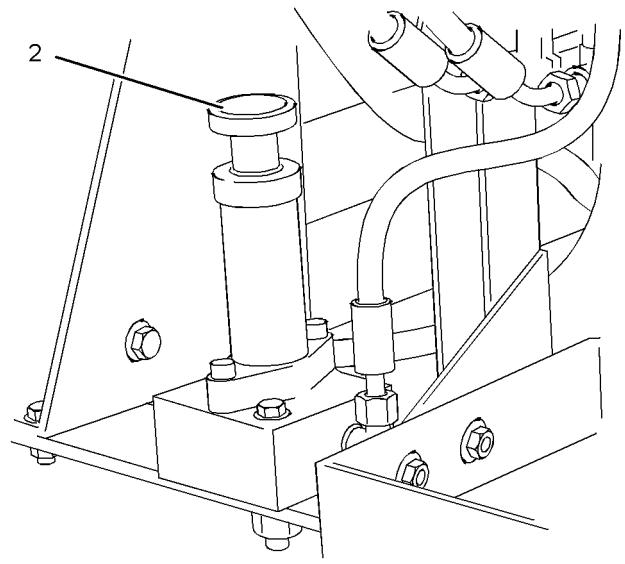


Illustration 107

Typical example

g01628105

- Unlock the fuel priming pump by turning the handle (2) counterclockwise.
- Operate the fuel priming pump in order to remove the air from the fuel filters. Operate the hand priming pump until fuel free from air flows from the vent screws.
- Tighten the vent screws securely.
- Operate the hand priming pump until a strong pressure is felt on the pump. Push the priming pump plunger inward and tighten the plunger by hand. Drain the tray that is below the filters.

Note: Do not loosen the high pressure fuel lines in order to purge air from the system. This procedure is not required.

- The engine fuel system should now be primed and the engine should now be able to start.
- Operate the engine starter and crank the engine. After the engine has started, operate the engine for a minimum of five minutes without load, immediately after air has been removed from the fuel system.

Note: Operating the engine for this period of time will help ensure that the fuel system is free of air.

- Select the required position for the control levers on the primary filters and the secondary filters.

12. If you have ensured that the air has been removed from the fuel system and the engine fails to start refer to Troubleshooting, "Engine Cranks but Will Not Start".

After the engine has stopped, you must wait for 60 seconds in order to allow the fuel pressure to be purged from the high pressure fuel lines before any service or repair is performed on the engine fuel lines. If necessary, perform minor adjustments. Repair any leaks from the low pressure fuel system and from the cooling, lubrication or air systems. Replace any high pressure fuel line that has leaked. Refer to Disassembly and assembly Manual, "Fuel Injection Lines - Install".

If you inspect the engine in operation, always use the proper inspection procedure in order to avoid a fluid penetration hazard. Refer to Operation and Maintenance Manual, "General hazard Information".

Priming a Duplex Fuel Filter with the Engine in Operation

Primary Filter

- 1.** Both the primary fuel filter and the secondary fuel filters must be replaced at the same time.
- 2.** After new filters have been installed the fuel system will need to be purged.
- 3.** Do not remove the vent screws on the primary fuel filter.

Note: The fuel system will be pressurized and the opening of a vent screw will allow fuel that is under pressure to escape.

- 4.** Slowly rotate the control lever on the primary fuel filter toward position B.
- 5.** Open the vent screw on the secondary fuel filter that is in operation. Ensure that the vent screw on the secondary fuel filter is covered with a soft cloth.
- 6.** The Opening of the vent screw and the rotation of the control lever must be performed simultaneously. Removal of the air from the filter will take a short period of time. Tighten the vent screw securely.

Note: Position B will allow the flow of fuel to both filters.

- 7.** Rotate the control lever to the required operating position.
- 8.** Prime the secondary filter.

Priming the Secondary Filter

- 1.** Both the secondary fuel filter and the primary fuel filters must be replaced at the same time.
- 2.** Loosen vent screw on the new secondary filter that has been replaced.
- 3.** Slowly rotate the control lever on the secondary fuel filter toward position B. During this process, the fuel will escape from the loosened vent screw. Removal of the air from the filter will take a short period of time.
- 4.** Tighten the vent screw when fuel free from air flows from the vent screws. Tighten the vent screw securely.

Note: Position B will allow the flow of fuel to both filters.

- 5.** Rotate the control lever to the required position.
- 6.** Drain the tray below the filters.

i03084280

Fuel System Primary Filter (Water Separator) Element - Replace

SMCS Code: 1260-510-FQ; 1263-510-FQ

Single Fuel Filter

WARNING

Fuel leaked or spilled onto hot surfaces or electrical components can cause a fire. To help prevent possible injury, turn the start switch off when changing fuel filters or water separator elements. Clean up fuel spills immediately.

Note: Refer to Testing and Adjusting Manual, "Cleanliness of Fuel System Components" for detailed information on the standards of cleanliness that must be observed during ALL work on the fuel system.

NOTICE

Ensure that the engine is stopped before any servicing or repair is performed.

Maintenance Section

Fuel System Primary Filter (Water Separator) Element - Replace

After the engine has stopped, you must wait for 60 seconds in order to allow the fuel pressure to be purged from the high pressure fuel lines before any service or repair is performed on the engine fuel lines. If necessary, perform minor adjustments. Repair any leaks from the low pressure fuel system and from the cooling, lubrication or air systems. Replace any high pressure fuel line that has leaked. Refer to Disassembly and assembly Manual, "Fuel Injection Lines - Install".

Ensure that all adjustments, maintenance and repairs are performed by authorized personnel that have the correct training.

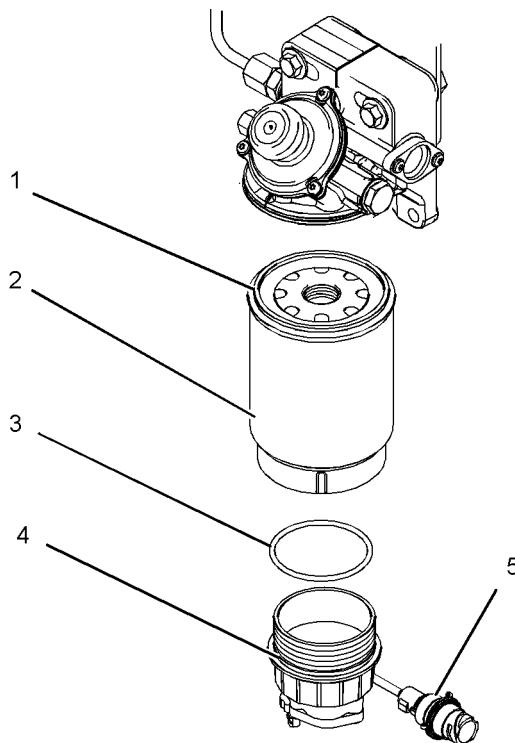


Illustration 108

g01636754

Typical example

1. The engine can have the ability to auto start. Ensure that the power supply is isolated before any service or repair is performed.
2. Turn the fuel supply valve to the OFF position before performing this maintenance.
3. Place a suitable container under the water separator in order to catch any fuel that might spill. Clean up any spilled fuel. Clean the outside of the water separator.
4. Disconnect the wiring harness (5) from the sensor on the bottom of the bowl (4).

5. Place a soft cloth over the vent screw on the filter. Open the vent screw in order to relieve the pressure that may be within the fuel system.
6. Open the drain valve. Allow the fluid to drain into the container. Tighten the drain valve by hand pressure only. Then, tighten the vent screw securely.
7. Rotate the bowl counterclockwise in order to remove the bowl. Remove O ring seal (3). Clean the bowl.
8. Use 1U-8760 Chain Wrench in order to remove old canister (2).
9. Lubricate O ring seal (1) with clean engine oil on the new canister. Install a new canister.
10. Spin on the canister until the O ring seal contacts the sealing surface. Then rotate the canister $\frac{3}{4}$ of a full turn. Do not use a tool in order to install the canister.
11. Install a new O ring seal into the bowl. Lubricate O ring seal (3) with clean engine oil. Install the bowl onto the new canister. Tighten the bowl securely. Install the wiring harness to the sensor.
12. Open the fuel supply valve. Remove the container and dispose of the fluid in a safe place.
13. The secondary filter must be replaced at the same time as the primary filter. Refer to the Operation and Maintenance Manual , "Fuel System Secondary Filter - Replace".

Duplex Fuel Filters

Some engines are installed with duplex fuel filters.

Filter Change with the Engine in Operation

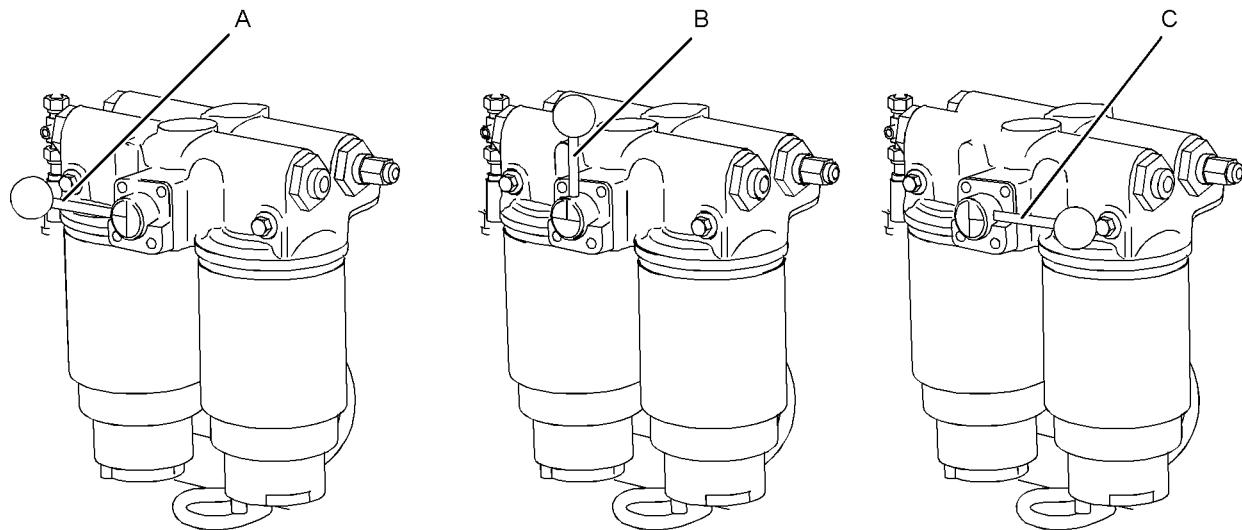


Illustration 109

g01627770

(A) The fuel flow is to the left hand fuel filter.
 (B) The fuel flow is to both fuel filters.

(C) The fuel flow is to the right hand fuel filter.

Note: The control lever will point in the direction of the fuel filter that is active. With the control lever in position A, the right hand fuel filter can be replaced. With the control lever in position C, the left hand fuel filter can be replaced.

1. Clean the outside of the filters. Isolate the contaminated filter. Rotate the control lever into position A or C.
2. Disconnect the wiring harness (5).
3. Relieve the pressure in the filter. Place a soft cloth over the vent screw and loosen the vent screw on the filter that has been isolated. Do not remove the vent screw.

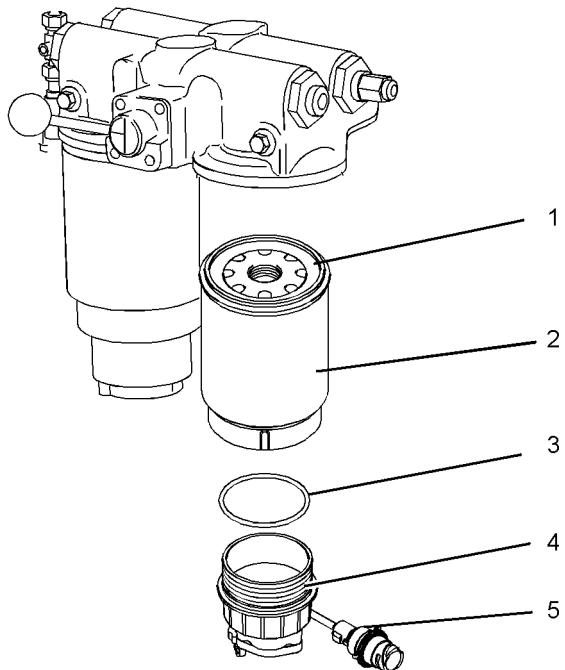


Illustration 110

g01637234

- (1) O ring seal
- (2) Canister
- (3) O ring seal
- (4) Bowl
- (5) Connector

4. Open the drain valve. Allow the fluid to drain into the tray. Tighten the drain valve by hand pressure only. Then, tighten the vent screw securely.
5. Rotate the bowl (4) counterclockwise in order to remove the bowl. Remove O ring seal (3). Clean the bowl.
6. Use 1U-8760 Chain Wrench in order to remove old canister (2).
7. Lubricate O ring seal (1) with clean engine oil on the new canister. Do not use a tool in order to install the canister. Install a new canister. Spin on the canister until the O ring seal contacts the sealing surface. Then rotate the canister $\frac{3}{4}$ of a full turn.
8. Install a new O ring seal into the bowl. Lubricate O ring seal (3) with clean engine oil. Install the bowl onto the new canister. Tighten the bowl securely. Install the wiring harness to the sensor.
9. The secondary filter must be replaced at the same time as the primary filter. Refer to the Operation and Maintenance Manual , "Fuel System Secondary Filter - Replace".

i03084422

Fuel System Primary Filter/Water Separator - Drain

SMCS Code: 1260-543; 1263-543

WARNING

Fuel leaked or spilled onto hot surfaces or electrical components can cause a fire. To help prevent possible injury, turn the start switch off when changing fuel filters or water separator elements. Clean up fuel spills immediately.

NOTICE

Ensure that the engine is stopped before any servicing or repair is performed.

NOTICE

The water separator can be under suction during normal engine operation. Ensure that the drain valve is tightened securely to help prevent air from entering the fuel system.

Single Fuel Filter

Ensure that all adjustments, maintenance and repairs are performed by authorized personnel that have had the correct training.

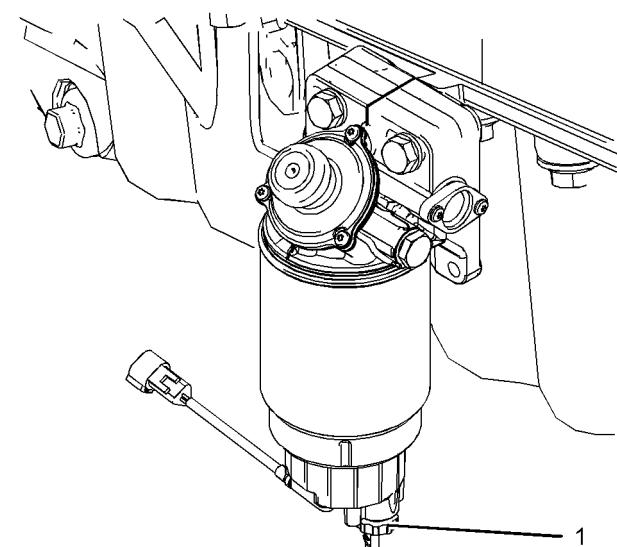


Illustration 111

g01565193

1. The engine can have the ability to auto start. Ensure that the power supply is isolated before any service or repair is performed.
2. Place a suitable container under the water separator in order to catch any fuel that might spill. Clean up any spilled fuel.
3. Open drain (1). Allow the fluid to drain into the container.
4. Tighten drain (1) by hand pressure only. Remove the tube and dispose of the drained fluid in a safe place.

Duplex Fuel Filters

Note: Perform this maintenance with the engine stopped. The engine can have the ability to auto start. Ensure that the power supply is isolated before any service, maintenance or repair is performed.

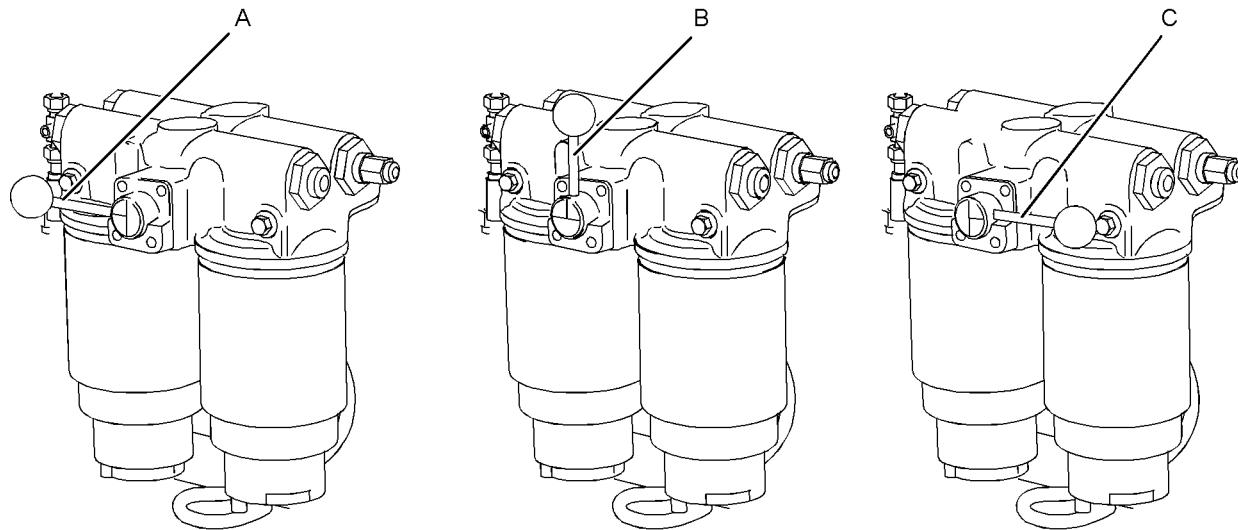


Illustration 112

Typical example

- (A) The fuel flow is to the left hand fuel filter.
- (B) The fuel flow is to both fuel filters.
- (C) The fuel flow is to the right hand fuel filter.

g01627770

4. Drain the tray below the filters.

i03085280

Fuel System Secondary Filter - Replace

SMCS Code: 1261-510-SE

⚠ WARNING

Fuel leaked or spilled onto hot surfaces or electrical components can cause a fire. To help prevent possible injury, turn the start switch off when changing fuel filters or water separator elements. Clean up fuel spills immediately.

Note: Refer to Testing and Adjusting Manual , “Cleanliness of Fuel System Components” for detailed information on the standards of cleanliness that must be observed during ALL work on the fuel system.

Ensure that all adjustments, maintenance and repairs are performed by authorized personnel that have had the correct training.

Single Filter

NOTICE

Ensure that the engine is stopped before any servicing or repair is performed.

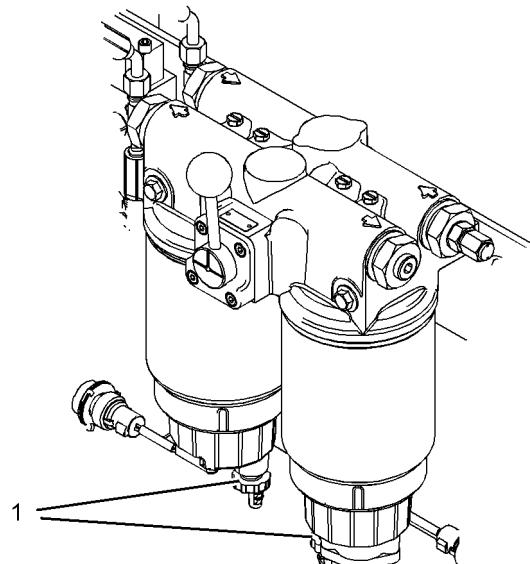


Illustration 113

Typical example

1. Ensure that the control lever is in position B. Refer to illustration 112. Fuel flow is to both fuel filters.
2. Open the drains (1) and allow the fluid to drain into the tray.
3. Tighten the drain by hand pressure only.

g01565033

Maintenance Section

Fuel System Secondary Filter - Replace

After the engine has stopped, you must wait for 60 seconds in order to allow the fuel pressure to be purged from the high pressure fuel lines before any service or repair is performed on the engine fuel lines. If necessary, perform minor adjustments. Repair any leaks from the low pressure fuel system and from the cooling, lubrication or air systems. Replace any high pressure fuel line that has leaked. Refer to Disassembly and assembly Manual, "Fuel Injection Lines - Install".

8. Prime the fuel system. Refer to the Operation and Maintenance Manual, "Fuel System - Prime" for more information.

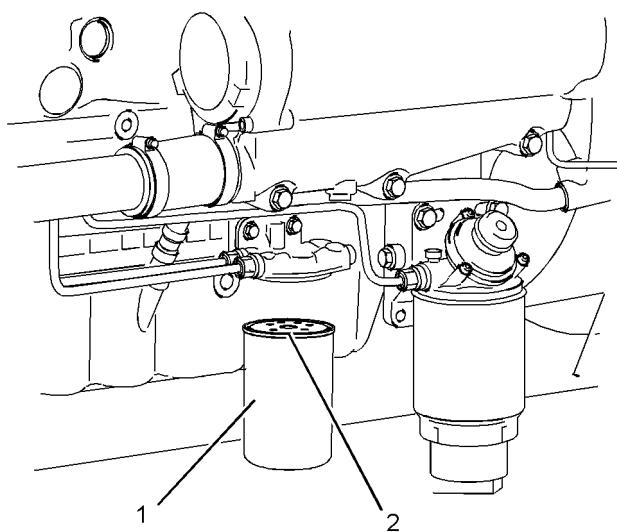


Illustration 114

g01566557

1. The engine can have the ability to auto start. Ensure that the power supply is isolated before any service or repair is performed.
2. Ensure that the fuel supply valve is in the OFF position. Place a suitable container under the fuel filter in order to catch any fuel that might spill. Clean up any spilled fuel.
3. Clean the outside of the fuel filter. Use 1U-8760 Chain Wrench in order to remove canister (1) from the engine and dispose of the canister in a safe place.
4. Lubricate O ring seal (2) with clean engine oil. Do not fill the new canister with fuel before the canister is installed.
5. Do not use a tool in order to install the canister. Tighten the canister by hand.
6. Install the new canister. Spin on the canister until the O ring seal contacts the filter base. Then rotate the canister 360 degree in order to tighten the canister correctly.
7. Remove the container and dispose of the fluid in a safe place. Open the fuel supply valve.

Duplex Filters

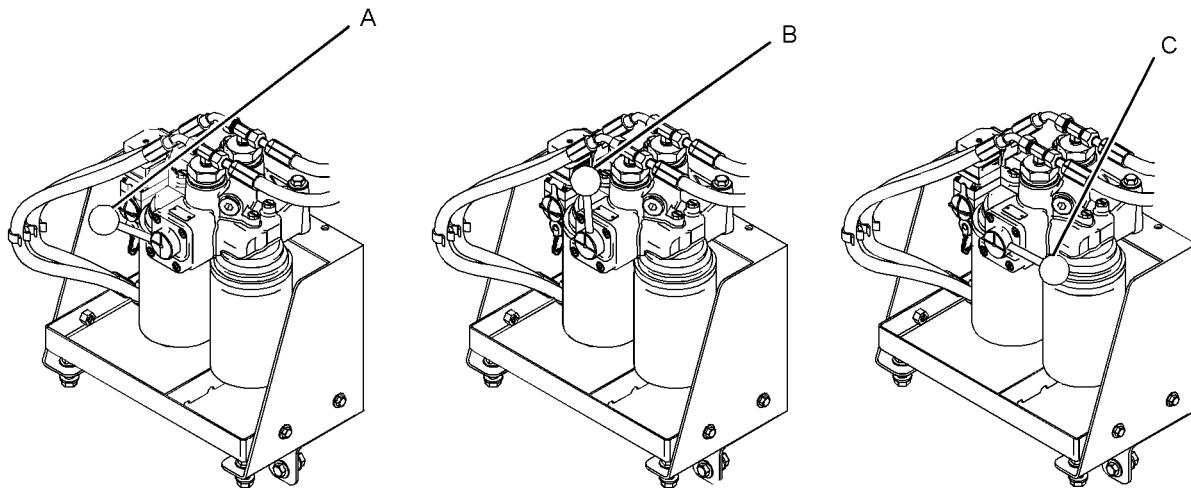


Illustration 115

g01674473

(A) The fuel flow is to the left hand fuel filter.
 (B) The fuel flow is to both fuel filters.

(C) The fuel flow is to the right hand fuel filter.

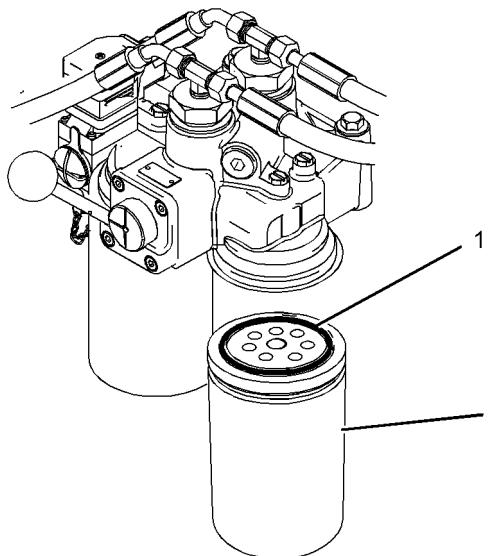


Illustration 116

g01566558

Typical example

1. The control lever will point in the direction of the fuel filter that is active. With the control lever in position A, the right hand fuel filter can be replaced. With the control lever in position C, the left hand fuel filter can be replaced. Refer to illustration 115.
2. Isolate the contaminated filter by rotating the control lever into position A or position C.

3. Place a soft cloth over the vent of the filter that has been isolated, before opening the vent screw.
4. Open the vent screw and then close the vent screw on the filter that has been isolated. This will relieve any pressure that is still in the filter.
5. Clean the outside of the fuel filter. Use 1U-8760 Chain Wrench in order to remove canister (2) from the engine and dispose of the canister in a safe place.
6. Lubricate O ring seal (1) with clean engine oil. Do not fill the new canister with fuel before the canister is installed.
7. Do not use a tool in order to install the canister. Tighten the canister by hand.
8. Install the new canister. Spin on the canister until the O ring seal contacts the filter base. Then rotate the canister 360 degree in order to tighten the canister correctly.
9. Prime the fuel system. Refer to Refer to the Operation and Maintenance Manual , "Fuel System Filter - Replace (Duplex Fuel Filters)".

i03071053

Fuel Tank Water and Sediment - Drain

SMCS Code: 1273-543-M&S

NOTICE

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, "Caterpillar Dealer Service Tool Catalog" or refer to Special Publication, PECJ0003, "Caterpillar Shop Supplies and Tools Catalog" for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to local regulations and mandates.

Fuel Tank

Fuel quality is critical to the performance and to the service life of the engine. Water in the fuel can cause excessive wear to the fuel system. Condensation occurs during the heating and cooling of fuel. The condensation occurs as the fuel passes through the fuel system and the fuel returns to the fuel tank. This causes water to accumulate in fuel tanks. Draining the fuel tank regularly and obtaining fuel from reliable sources can help to eliminate water in the fuel.

Drain the Water and the Sediment

Fuel tanks should contain some provision for draining water and draining sediment from the bottom of the fuel tanks.

Open the drain valve on the bottom of the fuel tank in order to drain the water and the sediment. Close the drain valve.

Check the fuel daily. Drain the water and sediment from the fuel tank after operating the engine or drain the water and sediment from the fuel tank after the fuel tank has been filled. Allow five to ten minutes before performing this procedure.

Fill the fuel tank after operating the engine in order to drive out moist air. This will help prevent condensation. Do not fill the tank to the top. The fuel expands as the fuel gets warm. The tank may overflow.

Some fuel tanks use supply pipes that allow water and sediment to settle below the end of the fuel supply pipe. Some fuel tanks use supply lines that take fuel directly from the bottom of the tank. If the engine is equipped with this system, regular maintenance of the fuel system filter is important.

Fuel Storage Tanks

Drain the water and the sediment from the fuel storage tank during the following conditions:

- Weekly
- Oil change
- Refill of the tank

This will help prevent water or sediment from being pumped from the storage tank into the engine fuel tank. A four micron(c) absolute filter for the breather vent on the fuel tank is also recommended. Refer to Special Publication, SENR9620, "Improving Fuel System Durability".

If a bulk storage tank has been refilled or moved recently, allow adequate time for the sediment to settle before filling the engine fuel tank. Internal baffles in the bulk storage tank will also help trap sediment. Filtering fuel that is pumped from the storage tank helps to ensure the quality of the fuel. When possible, water separators should be used.

i01936148

Generator - Dry

SMCS Code: 4450-569

WARNING

Personal injury or death can result from improper troubleshooting and repair procedures.

The following troubleshooting and repair procedures should only be performed by qualified personnel familiar with this equipment.

Note: The use of space heaters and occasional cranking of the engine will help to avoid drying the generator. Space heaters should be used continuously while the machine is stopped in order for the space heaters to be effective.

Refer to Safety Section, "Generator Isolating for Maintenance" for information regarding the procedure to safely isolate the generator.

If the insulation resistance values are less than 1 megohm for the stator or the insulation resistance values are less than 100,000 ohms for the other windings, one of the following drying procedures must be selected. This decision should be based on the following factors:

- the size of the unit
- the location of the unit
- the equipment that is available
- the experience of personnel

Measure insulation resistance at one hour intervals. Typically, the insulation resistance will slowly drop while the temperature is rising. The insulation resistance will then start to increase at a slow rate until the insulation resistance reaches a constant level.

The following methods can be used for drying a generator:

- Self-circulating air method
- Oven method
- Controlled current method

Self-Circulating Air Method

Blow hot air into the air intake for the generator. Disconnect the exciter field and run the engine. This will help circulate air. Operate the generator space heaters.

Oven Method

Disconnect the AVR. Place the entire generator inside a forced air drying oven for 24 hours at 110 °C (230 °F).

NOTICE

Use a forced air type oven rather than a radiant type oven.

Radiant type ovens can cause localized overheating.

Controlled Current Method

Table 22

Tools Needed		
Part Number	Description	Qty
8T-0900	Clamp on ammeter (0 - 1200 amperes)	1
	External 24 Volt DC Power Source	1
	Rheostat	1

Heat can be used in order to dry the generator windings. This heat can be created by allowing a controlled current to flow through the generator. No high voltages are generated during the following procedure. Therefore, insulation breakdown will not occur.

1. Disconnect the AVR.
2. Short circuit the three output power terminals with connectors that are capable of supporting the rated current. Try not to exceed 6 Amp per square millimeter.
3. Use a clamp-on ammeter in order to monitor the current through the short circuit connections.
4. Connect a 24 volt DC power source in series with a rheostat of 100 ohms or 50 Watts to the field terminals of the exciter. Make the connections with the correct polarity.
5. Open all the openings on the generator in order to allow air flow.
6. Operate the generator at the rated speed. Adjust the current in the exciter field with the rheostat. Obtain the rated output current in the short circuit connections.

i01880220

Generator - Inspect

SMCS Code: 4450-040

WARNING

Personal injury or death can result from improper troubleshooting and repair procedures.

The following troubleshooting and repair procedures should only be performed by qualified personnel familiar with this equipment.

⚠️ WARNING

The high voltage that is produced by an operating generator set can cause severe injury or death. Before performing any maintenance or repairs, ensure that the generator will not start.

Place the engine control switch in the “OFF” position. Attach “DO NOT OPERATE” tags to all starting controls. Disconnect the batteries or disable the starting system. Lock out all switchgear and automatic transfer switches that are associated with the generator.

Refer to Safety Section, “Generator Isolating for Maintenance” for information regarding the procedure to safely isolate the generator.

Proper maintenance of electrical equipment requires periodic visual examination of the generator and periodic visual examination of the windings. Proper maintenance of electrical equipment also requires appropriate electrical checks and appropriate thermal checks. Insulation material should be examined for cracks. The insulation material should be examined for accumulations of dirt and dust. If there is an insulation resistance value that is below normal, a conductive path may be present. This conductive path may be made of one of the following materials:

- Carbon
- Salt
- Metal dust
- Dirt that is saturated with moisture

These contaminants will develop a conductive path which may produce shorts. Cleaning is advisable if heavy accumulations of dirt can be seen or if heavy accumulations of dust can be seen. If excess dirt is the cause of a restriction in the ventilation, cleaning is also advisable. Restricted ventilation will cause excessive heating.

NOTICE

To avoid the possibility of deterioration to the generator windings, do not clean the generator unless there is visual, electrical, or thermal evidence that dirt is present.

If harmful dirt accumulations are present, a variety of cleaning techniques are available. The cleaning procedure that is used may be determined by one of the items on the following list:

- The extent of the cleaning procedure that is being attempted

- The type of enclosure of the generator
- The voltage rating of the generator
- The type of dirt that is being removed

Cleaning (Assembled Generators)

Cleaning may be required at the point of installation. At this point, complete disassembly of the generator may not be necessary or feasible. In this case, a vacuum cleaner should be used to pick up the following items: dry dirt, dust, and carbon. This will prevent the spreading of these contaminants.

A small nonconductive tube may need to be connected to the vacuum cleaner. This will allow the vacuum cleaner to clean the surfaces that are not exposed. After most of the dust has been removed, a small brush may be attached to the vacuum hose in order to loosen dirt that is more firmly attached to the surface.

After the initial cleaning with a vacuum, compressed air may be used to remove the remaining dust and dirt. Compressed air that is used for cleaning should be free of moisture and free of oil. Air pressure should be a maximum of 210 kPa (30 psi) in order to prevent mechanical damage to the insulation. If the above cleaning procedures are not effective, consult a Caterpillar dealer.

Cleaning (Disassembled Generators)

An initial insulation resistance check should be made on the generator in order to confirm electrical integrity. A minimum reading of one megohm would be expected with severely contaminated generators. A zero megohm reading may indicate an insulation breakdown. An insulation breakdown requires more than cleaning. An insulation breakdown requires repair.

A high pressure wash is normally an effective way to clean windings. This includes windings that have been exposed to flooding or windings that have been contaminated by salt. A solution of hot water and detergent is used for this method of cleaning.

A high pressure wash sprays a high velocity fluid stream of this solution over the generator that is being cleaned. This detergent washing is followed by multiple sprays of clean water. The clean water is used in order to remove the detergent or the clean water is used in order to dilute the detergent.

Allow the generator to dry at room temperature. Check the insulation resistance. The insulation resistance should now be normal. If the insulation resistance is not normal, repeat the procedure. It may be necessary to use solvents if the generator is contaminated with oil or if the generator is contaminated with grease.

Note: For more information on drying methods, refer to Special Instructions, SEHS9124, "Cleaning and Drying of Electric Set Generators".

i01878834

Generator Load - Check

SMCS Code: 4450-535-LA

⚠ WARNING

Personal injury or death can result from high voltage.

When power generation equipment must be in operation to make tests and/or adjustments, high voltage and current are present.

Improper test equipment can fail and present a high voltage shock hazard to its user.

Make sure the testing equipment is designed for and correctly operated for high voltage and current tests being made.

During normal operation, monitor the power factor and monitor generator loading.

When a three-phase generator is installed or when a three-phase generator is reconnected, ensure that the total current in any one phase does not exceed the nameplate rating. Each phase should carry the same load. This allows the three-phase generator to work at the rated capacity. If one phase current exceeds the nameplate amperage, an electrical imbalance will occur. An electrical imbalance can result in an electrical overload and an electrical imbalance can result in overheating on three-phase generators. This is not applicable to single-phase generators.

The power factor can be referred to as the efficiency of the load. This can be expressed as the ratio of kVA to actual kW. The power factor can be calculated by dividing kW by kVA. Power factor is expressed as a decimal. Power factor is used to mean the portion of current that is supplied to a system that is doing useful work. The portion of the current that is not doing useful work is absorbed in maintaining the magnetic field in motors. This current (reactive load) can be maintained without engine power.

i02377583

Generator Set - Test

SMCS Code: 4450-081

⚠ DANGER

DANGER: Shock/Electrocution Hazard-Do not operate this equipment or work on this equipment unless you have read and understand the instructions and warnings in the Operation and Maintenance Manual. Failure to follow the instructions or heed the warnings will result in serious injury or death.

⚠ WARNING

Personal injury or death can result from high voltage.

When power generation equipment must be in operation to make tests and/or adjustments, high voltage and current are present.

Improper test equipment can fail and present a high voltage shock hazard to its user.

Make sure the testing equipment is designed for and correctly operated for high voltage and current tests being made.

When servicing or repairing electric power generation equipment:

- Make sure the unit is off-line (disconnected from utility and/or other generators power service), and either locked out or tagged DO NOT OPERATE.
- Make sure the generator engine is stopped.
- Make sure all batteries are disconnected.
- Make sure all capacitors are discharged.

Table 23

Tools Needed		
Part Number	Part	Quantity
237-5130	Digital Multimeter	1
	12 VDC battery	1
	Potential Transformer	1

The generator set functional test is a simplified test that can be performed in order to determine if the generator is functional. The generator set functional test should be performed on a generator set that is under load.

The generator set functional test determines if the following statements happen:

- A phase voltage is being generated.
- The phase voltages are balanced.
- The phase voltages change relative to engine speed.

The generator set functional test consists of the following steps:

1. Stop the generator. Connect the potential transformer's high voltage winding to the generator terminals (T1) and (T2). Connect the voltmeter to the low voltage winding. If two transformers are available, connect the high voltage winding of the second transformer to the generator terminals (T1) and (T3). Connect the secondary terminals that correspond to generator terminal (T2) of both transformers together.
2. Disconnect wires "E+" and "E-" from the voltage regulator. Disconnect the generator from the load.
3. Connect a 12 VDC automotive battery to wires "E+" and "E-".
4. Measure the AC voltage across the low voltage terminals of the transformer that correspond to the following generator terminals: "T1" and "T2", "T2" and "T3", and "T3" and "T1". Record the voltages.

i02291365

Generator Set Vibration - Inspect

SMCS Code: 4450-040-VI

Excessive vibration will indicate a problem with the generator set. The vibration may be caused by the following:

- Misalignment of the coupling between the engine and the generator
- Faulty mounting or play in the coupling
- Incorrect balancing of the generator shaft or engine crankshaft
- A three-phase generator has too much load on a single phase.

- There is a short circuit in the stator.

Check for vibration damage. Vibration may cause the following problems:

- loose fittings
- loose bolts
- excessive noise
- cracked insulation

The following areas are susceptible to vibration damage:

- stator output leads
- protective sleeving
- insulation
- exposed electrical connections
- transformers
- fuses
- capacitors

Check the generator set's vibration level by using a broad spectrum analyzer.

i01592749

Heat Exchanger - Inspect

SMCS Code: 1379-040

The interval for the maintenance of the tube type heat exchanger depends on the operating environment of the vessel and on the operating time. The sea water that is circulated through the heat exchanger and the amount of operating time of the vessel affects the following items:

- Cleanliness of the tubes for the heat exchanger
- Effectiveness of the heat exchanger system

Operating in water that contains silt, sediment, salt, algae, etc will adversely affect the heat exchanger system. In addition, intermittent use of the vessel will adversely affect the heat exchanger system.

The following items indicate that the heat exchanger may require cleaning:

- Increased coolant temperature
- Engine overheating

- Excessive pressure drop between the water inlet and the water outlet

An operator that is familiar with the normal operating temperature of the coolant can determine when the coolant temperature is out of the normal range. Inspection and maintenance of the heat exchanger are required if the engine is overheating.

Cleaning the Heat Exchanger

- Remove the heat exchanger. Refer to the Service Manual for the procedure.
- Turn the heat exchanger core upside-down in order to remove debris.

NOTICE

Do not use a high concentration of caustic cleaner to clean the core. A high concentration of caustic cleaner can attack the internal metals of the core and cause leakage. Only use the recommended concentration of cleaner.

- Back flush the core with cleaner.

Caterpillar recommends the use of Hydrosolv liquid cleaner. Table 24 lists Hydrosolv liquid cleaners that are available from your Caterpillar dealer.

Table 24

Hydrosolv Liquid Cleaners ⁽¹⁾		
Part Number	Description	Size
1U-5490	Hydrosolv 4165	19 L (5 US gallon)
174-6854	Hydrosolv 100	19 L (5 US gallon)

⁽¹⁾ Use a two to five percent concentration of the cleaner at temperatures up to 93°C (200°F). Refer to Application Guide, NEHS0526 or consult your Caterpillar dealer for more information.

- Steam clean the core in order to remove any residue. Flush the tubes of the heat exchanger core. Remove any other trapped debris.
- Wash the core with hot, soapy water. Rinse the core thoroughly with clean water.

WARNING

Personal injury can result from air pressure.

Personal injury can result without following proper procedure. When using pressure air, wear a protective face shield and protective clothing.

Maximum air pressure at the nozzle must be less than 205 kPa (30 psi) for cleaning purposes.

- Dry the core with compressed air. Direct the air in the reverse direction of the normal flow.
- Inspect the core in order to ensure cleanliness. Pressure test the core. Many shops that service radiators are equipped to perform pressure tests. If necessary, repair the core.
- Install the heat exchanger. Refer to the Service Manual for the procedure.

For more information on cleaning the core, consult your Caterpillar dealer.

i02518232

Hoses and Clamps - Inspect/Replace

SMCS Code: 7554-040; 7554-510

WARNING

Contact with high pressure fuel may cause fluid penetration and burn hazards. High pressure fuel spray may cause a fire hazard. Failure to follow these inspection, maintenance and service instructions may cause personal injury or death.

If you inspect the engine in operation, always use the proper inspection procedure in order to avoid a fluid penetration hazard. Refer to Operation and Maintenance Manual, "General hazard Information".

Inspect all hoses for leaks that are caused by the following conditions:

- Cracking
- Softness
- Loose clamps

Replace hoses that are cracked or soft. Tighten any loose clamps.

Check for the following conditions:

- End fittings that are damaged or leaking
- Outer covering that is chafed or cut
- Exposed wire that is used for reinforcement
- Outer covering that is ballooning locally
- Flexible part of the hose that is kinked or crushed
- Armoring that is embedded in the outer covering

A constant torque hose clamp can be used in place of any standard hose clamp. Ensure that the constant torque hose clamp is the same size as the standard clamp.

Due to extreme temperature changes, the hose will harden. Hardening of the hoses will cause hose clamps to loosen. This can result in leaks. A constant torque hose clamp will help to prevent loose hose clamps.

Each installation application can be different. The differences depend on the following factors:

- Type of hose
- Type of fitting material
- Anticipated expansion and contraction of the hose
- Anticipated expansion and contraction of the fittings

Replace the Hoses and the Clamps

Refer to the OEM information for further information on removing and replacing fuel hoses (if equipped).

The following text describes a typical method of replacing coolant hoses. Refer to the OEM information for further information on the coolant system and the hoses for the coolant system.

WARNING

Pressurized System: Hot coolant can cause serious burns. To open the cooling system filler cap, stop the engine and wait until the cooling system components are cool. Loosen the cooling system pressure cap slowly in order to relieve the pressure.

1. Stop the engine. Allow the engine to cool.
2. Loosen the cooling system filler cap slowly in order to relieve any pressure. Remove the cooling system filler cap.

Note: Drain the coolant into a suitable, clean container. The coolant can be reused.

3. Drain the coolant from the cooling system to a level that is below the hose that is being replaced.
4. Remove the hose clamps.
5. Disconnect the old hose.
6. Replace the old hose with a new hose.
7. Install the hose clamps with a torque wrench.

Note: For the correct coolant, see this Operation and Maintenance Manual, "Fluid Recommendations".

8. Refill the cooling system. Refer to the OEM information for further information on refilling the cooling system.
9. Clean the cooling system filler cap. Inspect the cooling system filler cap's seals. Replace the cooling system filler cap if the seals are damaged. Install the cooling system filler cap.

10. Start the engine. Inspect the cooling system for leaks.

i01917577

Instrument Panel - Inspect

SMCS Code: 7451-040

Inspect the instrument panel for good condition. Perform the self test. All of the warning lamps should illuminate. If a warning lamp does not illuminate, replace the bulb immediately. If the alarm does not sound, investigate the problem and correct the problem.

Check the condition of all of the gauges. If a gauge is broken, repair the gauge or replace the gauge immediately.

Frequently monitor the gauges during normal operation.

Record the data in a log. Compare the new data to the data that was previously recorded. Comparing the new data to the recorded data will help to establish the trends of engine performance. A gauge reading that is abnormal may indicate a problem with operation or a problem with the gauge.

i01951994

Insulation - Test

SMCS Code: 4453-081; 4454-081; 4457-081;
4470-081

Recommended Periodic Insulation Tests

WARNING

The high voltage that is produced by an operating generator set can cause severe injury or death. Before performing any maintenance or repairs, ensure that the generator will not start.

Place the engine control switch in the "OFF" position. Attach "DO NOT OPERATE" tags to all starting controls. Disconnect the batteries or disable the starting system. Lock out all switchgear and automatic transfer switches that are associated with the generator.

Table 25

Tools Needed
142-5055 Insulation Testing Gp
9U-6003 Insulation Testing Gp

Periodically, use an insulation tester to check the insulation resistance of the generator's main stator winding. The frequency of this test is determined by the generator's environment. Previous insulation tester readings will also determine the frequency of this test.

Test the main stator windings with an insulation tester in the following situations:

- The generator set is started for the first time.
- The generator set is removed from storage.
- The generator set is operating in a humid environment. Test every three months.
- The generator set is not protected from the elements in an enclosed area. Test every three months.
- The generator set is installed in an enclosed area. This area needs to be low in humidity and this area needs to have steady temperatures. Test every twelve months (minimum).

- The generator set has not been run under load for three months. Test the generator set weekly. Use space heaters around the generator set if the generator is exposed to a sea water environment or if the humidity is above 75 percent. Also use space heaters if a test result was below 3 megohms.

Space heaters must be used whenever the generator set is not under load. Space heaters must also be used whenever salt is present or whenever high humidity is present. Using a space heater in this fashion is the only way to maintain insulation tester readings above one megohm. Use space heaters only when the generator is not running.

For additional information, refer to Special Instruction, SEHS9124, "Cleaning and Drying of Electric Set Generators".

Recommended Procedure for A Periodic Insulation Test

WARNING

Personal injury or death can result from electrocution.

The megohmmeter is applying a high voltage to the circuit.

To avoid electrocution, do not touch the instrument leads without first discharging them. When finished testing also discharge the generator windings.

1. Take the generator out of service.
2. Visually inspect the generator for moisture. If moisture exists, do not perform this insulation test. Dry the unit first. Refer to Special Instruction, SEHS9124, "Cleaning and Drying of Electric Set Generators".
3. Inspect the installation. Determine the equipment that will be tested by the insulation tester.
4. Discharge the capacitance of the windings.
5. Isolate the stator windings of the generator by disconnecting all other leads and cables from the generator terminals. This includes connections to the voltage regulator, the control panel, the switchgear or other devices.
6. Connect the insulation tester's RED lead to ground.
7. Connect the insulation tester's BLACK lead to the wye point or star point of the generator's windings.

8. For units that are 600 volts or less, set the voltage to 500 Volts. For units that are more than 600 volts, set the voltage to 1000 Volts.

9. Use the 30/60 Time Resistance Method:

- a.** Apply voltage.
- b.** Observe the readings at 30 seconds. Observe the readings at 60 seconds.
- c.** Record the 60 second reading. This reading must be corrected for temperature.
- d.** Record temperature.
- e.** Record humidity.
- f.** Remove voltage.

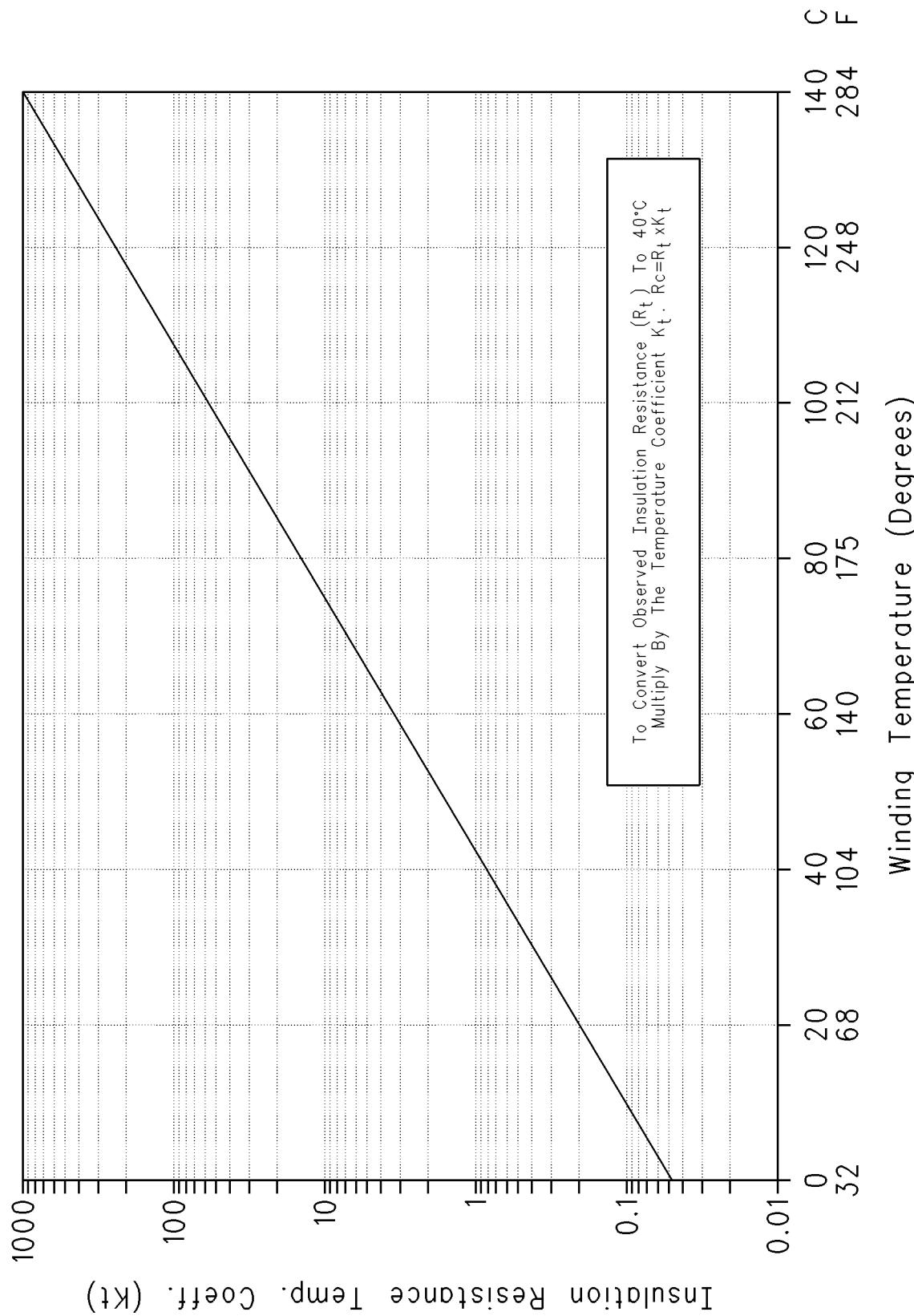
10. Evaluate the readings. The actual value of the resistance may vary greatly between generators. For this reason, the insulation's condition must be evaluated. Base this evaluation on the comparison between the 60 second resistance readings and the readings that were taken on previous dates. These two readings must be taken under similar conditions. If a 60 second resistance reading has a 50 percent reduction from the previous reading, the insulation may have absorbed too much moisture.

Switch the insulation tester to the "OFF" position. This will discharge the insulation tester's leads. Disconnect the insulation tester's leads.

Note: The results from the insulation resistance checks indicate when cleaning and/or repairing is becoming critical. Generally, insulation resistance will vary greatly with temperature. Therefore, always test at the same temperature and humidity. Refer to Illustration 117.

Serial Number (Engine)_____

Serial Number (Generator)_____

Approx. Insulation Resistance Variation
with Temperature (IEEE 43-1974)

i03230758

Jacket Water Heater - Check

SMCS Code: 1383-535

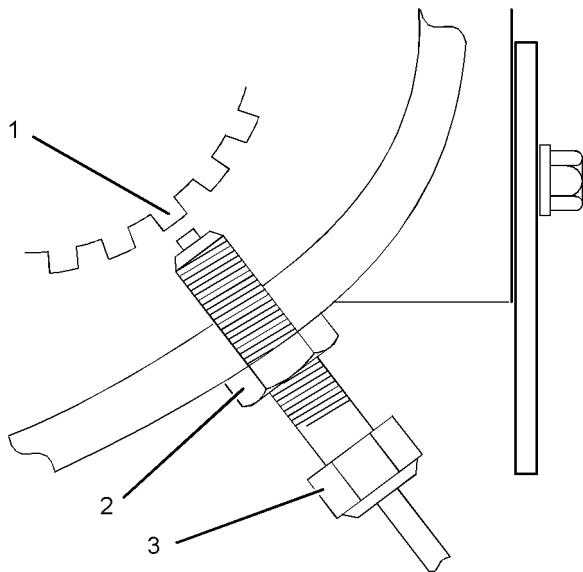
Jacket water heaters help to improve startability in ambient temperatures that are below 21 °C (70 °F). All installations that require automatic starting should have jacket water heaters.

Check the operation of the jacket water heater. Check the operation of the circulation pump, if equipped. For an ambient temperature of 0 °C (32 °F), the heater should maintain the jacket water coolant temperature at approximately 32 °C (90 °F).

i03097240

Magnetic Pickups - Clean/Inspect

SMCS Code: 1907-040; 7400-040; 7400-070



g01578033

Illustration 118

Typical example

Note: The engine can have the ability to auto start. Ensure that the power supply is isolated before any service or repair is performed.

1. Remove the magnetic pickup (3) from the flywheel housing. Check the condition of the end of the magnetic pickup. Check for signs of wear and contaminants.
2. Clean the metal shavings and other debris from the face of the magnet.

3. Install the magnetic pickup until the magnet comes in contact with a tooth on the flywheel ring gear (1).

4. Back out 180 degrees and tighten the locknut (2) to $45 \pm 7 \text{ N}\cdot\text{m}$ ($33 \pm 5 \text{ lb ft}$).

Note: Ensure that the magnetic pickup can not rotate when the locknut is tightened.

Refer to the Service Manual for more information on the magnetic pickup.

i01515272

Overhaul Considerations

SMCS Code: 7595-043

Reduced hours of operation at full load will result in a lower average power demand. A decreased average power demand should increase both the engine service life and the overhaul interval.

The need for an overhaul is generally indicated by increased fuel consumption and by reduced power.

The following factors are important when a decision is being made on the proper time for an engine overhaul:

- The need for preventive maintenance
- The quality of the fuel that is being used
- The operating conditions
- The results of the S-O-S analysis

Oil Consumption as an Overhaul Indicator

Oil consumption, fuel consumption, and maintenance information can be used to estimate the total operating cost for your Caterpillar engine. Oil consumption can also be used to estimate the required capacity of a makeup oil tank that is suitable for the maintenance intervals.

Oil consumption is in proportion to the percentage of the rated engine load. As the percentage of the engine load is increased, the amount of oil that is consumed per hour also increases.

The oil consumption rate (brake specific oil consumption) is measured in grams per kW/h (lb per bhp). The brake specific oil consumption (BSOC) depends on the engine load. Consult your Caterpillar dealer for assistance in determining the typical oil consumption rate for your engine.

When an engine's oil consumption has risen to three times the original oil consumption rate due to normal wear, an engine overhaul should be scheduled. There may be a corresponding increase in blowby and a slight increase in fuel consumption.

Overhaul Options

Before Failure Overhaul

A planned overhaul before failure may be the best value for the following reasons:

- Costly unplanned downtime can be avoided.
- Many original parts can be reused according to the standards for reusable parts.
- The engine's service life can be extended without the risk of a major catastrophe due to engine failure.
- The best cost/value relationship per hour of extended life can be attained.

After Failure Overhaul

If a major engine failure occurs and the engine must be removed, many options are available. An overhaul should be performed if the engine block or the crankshaft needs to be repaired.

If the engine block is repairable and/or the crankshaft is repairable, the overhaul cost should be between 40 percent and 50 percent of the cost of a new engine with a similar exchange core.

This lower cost can be attributed to three aspects:

- Specially designed Caterpillar engine features
- Caterpillar dealer exchange components
- Caterpillar Inc. remanufactured exchange components

Overhaul Recommendation

To minimize downtime, Caterpillar Inc. recommends a scheduled engine overhaul by your Caterpillar dealer before the engine fails. This will provide you with the best cost/value relationship.

Note: Overhaul programs vary according to the engine application and according to the dealer that performs the overhaul. Consult your Caterpillar dealer for specific information about the available overhaul programs and about overhaul services for extending the engine life.

If an overhaul is performed without overhaul service from your Caterpillar dealer, be aware of the following maintenance recommendations.

Rebuild or Exchange

Cylinder Head Assembly, Oil Pump, and Fuel Transfer Pump

These components should be inspected according to the instructions that are found in various Caterpillar reusability publications. The Special Publication, SEBF8029 lists the reusability publications that are needed for inspecting the engine parts.

If the parts comply with the established inspection specifications that are expressed in the reusable parts guideline, the parts should be reused.

Parts that are not within the established inspection specifications should be dealt with in one of the following manners:

- Salvaging
- Repairing
- Replacing

Using out-of-spec parts can result in the following problems:

- Unscheduled downtime
- Costly repairs
- Damage to other engine parts
- Reduced engine efficiency
- Increased fuel consumption

Reduced engine efficiency and increased fuel consumption translates into higher operating costs. Therefore, Caterpillar Inc. recommends repairing out-of-spec parts or replacing out-of-spec parts.

Inspection and/or Replacement

Crankshaft Bearings and Crankshaft Seals

The following components may not last until the second overhaul.

- Thrust bearings
- Main bearings
- Rod bearings
- Crankshaft seals

Caterpillar Inc. recommends the installation of new parts at each overhaul period.

Inspect these parts while the engine is disassembled for an overhaul.

Inspect the crankshaft for any of the following conditions:

- Deflection
- Damage to the journals
- Bearing material that has seized to the journals

Check the journal taper and the profile of the crankshaft journals. Check these components by interpreting the wear patterns on the following components:

- Rod bearing
- Main bearings

Inspect the camshaft for damage to the journals and to the lobes.

Note: If the camshaft is removed for any reason, use the magnetic particle inspection process to check for cracks in the camshaft.

Inspect the following components for signs of wear or for signs of scuffing:

- Camshaft bearings
- Lifters

Caterpillar Inc. recommends replacing the crankshaft vibration damper.

Oil Cooler Core

During an overhaul, Caterpillar Inc. recommends the removal of the oil cooler core. Clean the oil cooler core. Then, pressure test the oil cooler core.

NOTICE

Do not use caustic cleaners to clean the core.

Caustic cleaners can attack the internal metals of the core and cause leakage.

Note: Use this cleaning procedure to clean the oil cooler core.

1. Remove the oil cooler core.

2. Remove any debris from the oil cooler core. To remove debris from the oil cooler core, turn the oil cooler core onto one end.

3. Flush the oil cooler core internally with cleaner in order to loosen foreign substances. This will also help to remove oil from the oil cooler core.

Note: Caterpillar Inc. recommends the use of Hydrosolv Liquid Cleaners. Table 26 lists the Hydrosolv Liquid Cleaners that are available from your Caterpillar dealer.

Table 26

Hydrosolv Liquid Cleaners		
Part Number	Description	Size
1U-5490	Hydrosolv4165	19 L (5 US gal)
1U-5492	Hydrosolv100	19 L (5 US gallon)

4. Use steam to clean the oil cooler core. This removes any remaining residue from the cleaner. Flush the fins of the oil cooler core. Remove any other trapped debris.

5. Wash the oil cooler core with hot, soapy water. Rinse the oil cooler core thoroughly with clean water.

WARNING

Personal injury can result from air pressure.

Personal injury can result without following proper procedure. When using pressure air, wear a protective face shield and protective clothing.

Maximum air pressure at the nozzle must be less than 205 kPa (30 psi) for cleaning purposes.

6. Dry the oil cooler core with compressed air. Direct the air in the reverse direction of the normal flow.

7. Inspect the components in order to ensure cleanliness. The oil cooler core should be pressure tested. Repair the oil cooler core, if necessary. Install the oil cooler core.

For more information about cleaning the cores, consult your Caterpillar dealer.

Obtain Coolant Analysis

The concentration of supplemental coolant additive (SCA) should be checked regularly with test kits or with S-O-S Coolant Analysis (Level 1). Further coolant analysis is recommended when the engine is overhauled.

For example, considerable deposits are found in the water jacket areas on the external cooling system, but the concentrations of coolant additives were carefully maintained. The coolant water probably contained minerals that were deposited on the engine over time.

A coolant analysis can be conducted in order to verify the condition of the water that is being used in the cooling system. A full water analysis can be obtained by consulting your local water utility company or an agricultural agent. Private laboratories are also available for water analysis.

Caterpillar Inc. recommends an S·O·S Coolant Analysis (Level 2).

S·O·S Coolant Analysis (Level 2)

An S·O·S Coolant Analysis (Level 2) is a comprehensive coolant analysis which completely analyzes the coolant and the effects on the cooling system. An S·O·S Coolant Analysis (Level 2) provides the following information:

- Complete S·O·S Coolant Analysis (Level 1)
- Visual inspection of properties
- Identification of metal corrosion
- Identification of contaminants
- Identification of built up impurities (corrosion and scale)

S·O·S Coolant Analysis (Level 2) provides a report of the results of both the analysis and the maintenance recommendations.

For more information about coolant analysis, see your Caterpillar dealer.

i01216962

Power Factor - Check

SMCS Code: 4450-535-PWR

The power factor of a system can be determined by a power factor meter or by calculations. The power factor can be calculated by dividing kW by kVA. Power factor is expressed as a decimal.

i02559063

Radiator - Clean

SMCS Code: 1353-070

Note: Adjust the frequency of cleaning according to the effects of the operating environment.

Inspect the radiator for these items: damaged fins, corrosion, dirt, grease, insects, leaves, oil, and other debris. Clean the radiator, if necessary.

WARNING

Personal injury can result from air pressure.

Personal injury can result without following proper procedure. When using pressure air, wear a protective face shield and protective clothing.

The maximum air pressure for cleaning purposes must be reduced to 205 kPa (30 psi) when the air nozzle is deadheaded.

Pressurized air is the preferred method for removing loose debris. Direct the air in the opposite direction of the fan's air flow. Hold the nozzle approximately 6 mm (0.25 inch) away from the fins. Slowly move the air nozzle in a direction that is parallel with the tubes. This will remove debris that is between the tubes.

Pressurized water may also be used for cleaning. The maximum water pressure for cleaning purposes must be less than 275 kPa (40 psi). Use pressurized water in order to soften mud. Clean the core from both sides.

Use a degreaser and steam for removal of oil and grease. Clean both sides of the core. Wash the core with detergent and hot water. Thoroughly rinse the core with clean water.

After cleaning, start the engine and accelerate the engine to high idle rpm. This will help in the removal of debris and drying of the core. Stop the engine. Use a light bulb behind the core in order to inspect the core for cleanliness. Repeat the cleaning, if necessary.

Inspect the fins for damage. Bent fins may be opened with a "comb". Inspect these items for good condition: welds, mounting brackets, air lines, connections, clamps, and seals. Make repairs, if necessary.

For more detailed information on cleaning and inspection, refer to Special Publication, SEBD0518, "Know Your Cooling System".

i01880286

Rotating Rectifier - Check

SMCS Code: 4465-535

WARNING

The high voltage that is produced by an operating generator set can cause severe injury or death. Before performing any maintenance or repairs, ensure that the generator will not start.

Place the engine control switch in the "OFF" position. Attach "DO NOT OPERATE" tags to all starting controls. Disconnect the batteries or disable the starting system. Lock out all switchgear and automatic transfer switches that are associated with the generator.

Check the exciter armature. Ensure that the rotating rectifier is tight. If a failure of a rectifier is suspected, refer to Maintenance Procedure, "Rotating Rectifier - Test".

i01936391

Rotating Rectifier - Test

SMCS Code: 4465-081

WARNING

The high voltage that is produced by an operating generator set can cause severe injury or death. Before performing any maintenance or repairs, ensure that the generator will not start.

Place the engine control switch in the "OFF" position. Attach "DO NOT OPERATE" tags to all starting controls. Disconnect the batteries or disable the starting system. Lock out all switchgear and automatic transfer switches that are associated with the generator.

Use the following procedure in order to test the rotating rectifier.

1. Stop the generator set. Disconnect the wires for the AVR and isolate the wires for the AVR.
2. Make an assembly for separate excitation. The assembly can use a 12 volt battery or a variable DC power supply as a power source. Refer to Step 3 for an assembly that uses a 12 Volt battery. Refer to Step 4 for an assembly that uses a variable DC power supply.

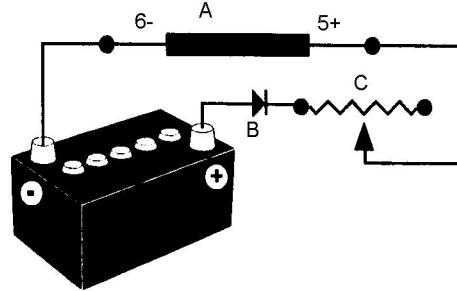


Illustration 119

g01015807

(A) Exciter Field
(B) Diode (1 Amp)
(C) Rheostat (50 Ohms 300 Watts)

3. Connect a 12 volt battery in series with a rheostat (C) of "50 Ohms 300 Watts" and a diode (B) on both wires for the exciter field (5+ and 6-). Go to step 5.

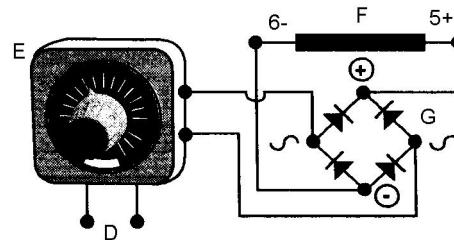


Illustration 120

g01015808

(D) AC supply
(E) Variable power supply
(F) Exciter field
(G) Diode bridge

4. Connect a variable power supply and a diode bridge to both of the wires for the exciter field (5+) and (6-).
5. The assembly should have characteristics that are compatible with the power for the field excitation of the generator.
6. Operate the generator set at rated speed.
7. Gradually increase the current of the exciter field by adjusting the rheostat or the variable power supply. Measure the output voltage and the current at no load. Measure the output voltage and measure the current at no load.

8. The generator is operating properly when the output voltage is at the rated value and the output voltage is balanced within one percent for the rated level of excitation.

i00905687

Sea Water Strainer - Clean/Inspect

SMCS Code: 1371-040; 1371-070

The sea water strainer must be clean in order to allow proper engine cooling. Check the sea water strainer for plugging. Inspect the sea water strainer more frequently if the vessel is being operated in water which is shallow or dirty. Refer to the OEM recommendations for more information about inspecting and cleaning the sea water strainer.

Ensure that the auxiliary water pump is primed and that the suction line is open.

1. Remove the sea water strainer and clean the screen. Remove any dirt and debris.
2. Install the sea water strainer. Fill the sea water strainer and the suction line for the auxiliary water pump with water.

i00151038

Severe Service Application - Check

SMCS Code: 1000-535

Severe service is an application of an engine that exceeds current published standards for that engine. Caterpillar maintains standards for the following engine parameters:

- Performance (power range, speed range, and fuel consumption)
- Fuel quality
- Altitude range
- Maintenance intervals
- Oil selection and maintenance
- Coolant selection and maintenance
- Environmental qualities
- Installation

Refer to the standards for the engine or consult with your Caterpillar dealer in order to determine if the engine is operating within the defined parameters.

Severe service operation can accelerate component wear. Engines that operate under severe conditions may need more frequent maintenance intervals in order to ensure maximum reliability and retention of full service life.

Due to individual applications, it is not possible to identify all of the factors which can contribute to severe service operation. Consult your Caterpillar dealer for the unique maintenance that is necessary for the engine.

The operating environment, improper operating procedures and improper maintenance procedures can be factors which contribute to severe service conditions.

Environmental Factors

Ambient temperatures – The engine may be exposed to extended operation in extremely cold environments or hot environments. Valve components can be damaged by carbon buildup if the engine is frequently started and stopped in very cold temperatures. Extremely hot inlet air reduces engine performance.

Air Quality – The engine may be exposed to extended operation in an environment that is dirty or dusty, unless the equipment is cleaned regularly. Mud, dirt and dust can encase components. Maintenance can be very difficult. The buildup can contain corrosive chemicals.

Buildup – Compounds, elements, corrosive chemicals and salt can damage some components.

Altitude – Problems can arise when the engine is operated at altitudes that are higher than the intended settings for that application. Necessary adjustments should be made.

Improper Operating Procedures

- Extended operation at low idle
- Frequent hot shutdowns
- Operating at excessive loads
- Operating at excessive speeds
- Operating outside the intended application

Improper Maintenance Procedures

- Extending the maintenance intervals
- Failure to use recommended fuel, lubricants and coolant/antifreeze

i03108463

Standby Generator Set Maintenance Recommendations

SMCS Code: 4450-041

A standby generator set may not need to be used very often. However, the generator set is usually needed for operation in an emergency situation. Maintenance of the standby generator set is very important for the following reasons:

- The generator set must always be in excellent operating condition.
- The generator set must be ready to work under load at any time.

Establishing a Preventive Maintenance Program will provide these benefits:

- Maximum availability of the standby generator set
- Longer service life for the generator set
- Minimum of expensive repairs

Your Caterpillar dealer can help you to establish an effective Preventive Maintenance Program for your generator set. Consult your Caterpillar dealer for details.

Maintenance and Operation Procedures



WARNING

The high voltage that is produced by an operating generator set can cause severe injury or death. Before performing any maintenance or repairs, ensure that the generator will not start.

Place the engine control switch in the "OFF" position. Attach "DO NOT OPERATE" tags to all starting controls. Disconnect the batteries or disable the starting system. Lock out all switchgear and automatic transfer switches that are associated with the generator.

The recommended maintenance for the generator set is listed in this Operation and Maintenance Manual, "Maintenance Interval Schedule (Standby Generator Sets)" (Maintenance Section).

Maintenance and Repair

The maintenance that is recommended for Every Week can be performed by an authorized operator. The maintenance that is recommended for the subsequent maintenance intervals must be performed by an authorized service technician or by your Caterpillar dealer.

Unless other instructions are provided, perform maintenance and repairs under the following conditions:

- The engine is stopped.
- The starting system is disabled.
- The generator does not pose an electrical shock hazard.
- The generator is disconnected from the load.

Operation

To ensure proper operation, the generator set must be exercised regularly. For instructions on operating the generator set, see the Operation and Maintenance Manual for the generator set control panel.

For these operation procedures, follow the instructions that are provided in this Operation and Maintenance Manual, "Operation Section": starting the engine, engine operation, and stopping the engine.

Record Keeping

Maintain a record in order to document these items: gauge readings, maintenance that is performed, problems, and repairs.

Space Heaters

Moisture causes damage to generators and other electrical equipment. Make every effort to keep the generator set as dry as possible.

Generators can operate without problems in humid environments. However, problems can occur when the generator is inactive. Moisture can condense on the windings. This can result in poor performance. Also, damage to the windings can occur.

Use space heaters in order to help keep the windings dry. When the generator is not active, ensure that the space heaters are operating. When the generator is operating, turn OFF the space heaters.

i02348493

Starting Motor - Inspect

SMCS Code: 1451-040; 1453-040

Caterpillar recommends a scheduled inspection of the starting motor. If the starting motor fails, the engine may not start in an emergency situation.

Check the starting motor for correct operation. Check the electrical connections and clean the electrical connections. Refer to the Systems Operation, Testing and Adjusting Manual, "Electric Starting System - Test" for more information on the checking procedure and for specifications or consult your Caterpillar dealer for assistance.

i03153545

Turbocharger - Inspect

SMCS Code: 1052-040; 1052

A regular visual inspection of the turbocharger is recommended. If the turbocharger fails during engine operation, damage to the turbocharger compressor wheel and/or to the engine may occur. Damage to the turbocharger compressor wheel can cause additional damage to the pistons, the valves, and the cylinder head.

NOTICE

Turbocharger bearing failures can cause large quantities of oil to enter the air intake and exhaust systems. Loss of engine lubricant can result in serious engine damage.

Minor leakage of oil into a turbocharger under extended low idle operation should not cause problems as long as a turbocharger bearing failure has not occurred.

When a turbocharger bearing failure is accompanied by a significant engine performance loss (exhaust smoke or engine rpm up at no load), do not continue engine operation until the turbocharger is renewed.

A visual inspection of the turbocharger can minimize unscheduled downtime. A visual inspection of the turbocharger can also reduce the chance for potential damage to other engine parts.

Removal and Installation

Note: The turbochargers that are supplied are nonserviceable.

For options regarding the removal, installation, and replacement, consult your Caterpillar dealer. Refer to the Disassembly and Assembly Manual, "Turbocharger - Remove and Turbocharger - Install" for further information.

Inspecting

NOTICE

The compressor housing for the turbocharger must not be removed from the turbocharger for inspection or removed for the cleaning of the compressor.

1. Remove the pipe from the turbocharger exhaust outlet and remove the air intake pipe to the turbocharger. Visually inspect the piping for the presence of oil. Clean the interior of the pipes in order to prevent dirt from entering during reassembly.
2. Check for obvious heat discoloration of the turbocharger. Check for any loose bolts or any missing bolts. Check for damage to the oil supply line and the oil drain line. Check for cracks in the housing of the turbocharger. Ensure that the compressor wheel can rotate freely.
3. Check for the presence of oil. If oil is leaking from the back side of the compressor wheel, there is a possibility of a failed turbocharger oil seal.

The presence of oil may be the result of a restriction of the line for the intake air (clogged air filters), which causes the turbocharger to slobber.

4. Inspect the bore of the housing of the turbine outlet for corrosion.
5. Fasten the air intake pipe and the exhaust outlet pipe to the turbocharger housing. Ensure that all clamps are installed correctly and that all clamps are tightened securely.

i03285120

Walk-Around Inspection

SMCS Code: 1000-040

A walk-around inspection should only take a few minutes. When the time is taken to perform these checks, costly repairs and accidents can be avoided.

For maximum engine service life, make a thorough inspection of the engine compartment before starting the engine. Look for items such as oil leaks or coolant leaks, loose bolts, worn belts, loose connections and trash buildup. Make repairs, as needed:

Inspect the Tube for the Crankcase Breather

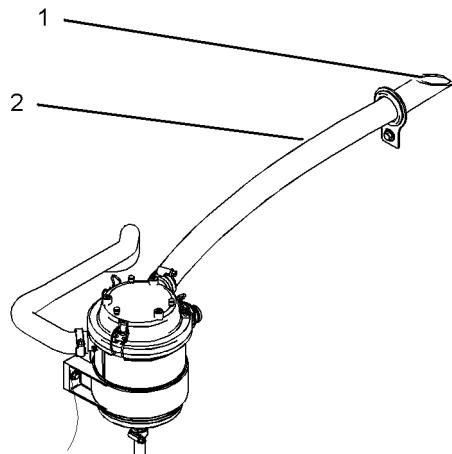


Illustration 121

g01671974

Inspect the breather tube (2) for damage. Ensure that the outlet (1) is clean and free from any obstructions. Ice can cause an obstruction in the tube in adverse weather conditions.

Inspect the Engine for Leaks and for Loose Connections

- The guards must be in the correct place. Repair damaged guards or replace missing guards.
- Wipe all caps and plugs before the engine is serviced in order to reduce the chance of system contamination.

NOTICE

For any type of leak (coolant, lube, or fuel) clean up the fluid. If leaking is observed, find the source and correct the leak. If leaking is suspected, check the fluid levels more often than recommended until the leak is found or fixed, or until the suspicion of a leak is proved to be unwarranted.

NOTICE

Accumulated grease and/or oil on an engine is a fire hazard. Remove the accumulated grease and oil. Refer to this Operation and Maintenance Manual, "Engine - Clean" for more information.

- Ensure that the cooling system hoses are correctly clamped and that the cooling system hoses are tight. Check for leaks. Check the condition of all pipes.
- Inspect the water pump for coolant leaks.

Note: The water pump seal is lubricated by the coolant in the cooling system. It is normal for a small amount of leakage to occur as the engine cools down and the parts contract.

Excessive coolant leakage may indicate the need to replace the water pump. Remove the water pump. Refer to Disassembly and Assembly, "Water Pump - Remove and Install". For more information, consult your Caterpillar dealer.

- Inspect the lubrication system for leaks at the front crankshaft seal, the rear crankshaft seal, the oil pan, the oil filters and the rocker cover.
- Inspect the piping for the air intake system and the elbows for cracks and for loose clamps. Ensure that hoses and tubes are not contacting other hoses, tubes, wiring harnesses, etc.
- Ensure that the areas around the rotating parts are clear.
- Inspect the alternator belts and any accessory drive belts for cracks, breaks or other damage.
- Inspect the wiring harness for damage.

Belts for multiple groove pulleys must be replaced as matched sets. If only one belt is replaced, the belt will carry more load than the belts that are not replaced. The older belts are stretched. The additional load on the new belt could cause the belt to break.

High Pressure Fuel Lines

WARNING

Contact with high pressure fuel may cause fluid penetration and burn hazards. High pressure fuel spray may cause a fire hazard. Failure to follow these inspection, maintenance and service instructions may cause personal injury or death.

After the engine has stopped, you must wait for 60 seconds in order to allow the fuel pressure to be purged from the high pressure fuel lines before any service or repair is performed on the engine fuel lines. If necessary, perform minor adjustments. Repair any leaks from the low pressure fuel system and from the cooling, lubrication or air systems. Replace any high pressure fuel line that has leaked. Refer to Disassembly and Assembly Manual, "Fuel Injection Lines - Install".

If you inspect the engine in operation, always use the proper inspection procedure in order to avoid a fluid penetration hazard. Refer to Operation and Maintenance Manual, "General hazard Information".

Visually inspect the high pressure fuel lines for damage or signs of fuel leakage. Replace any damaged high pressure fuel lines or high pressure fuel lines that have leaked.

Ensure that all clips on the high pressure fuel lines are in place and that the clips are not loose.

- Inspect the rest of the fuel system for leaks. Look for loose fuel line clamps.
- Drain the water and the sediment from the fuel tank on a daily basis in order to ensure that only clean fuel enters the fuel system.
- Inspect the wiring and the wiring harnesses for loose connections and for worn wires or frayed wires. Check for any loose tie-wraps or missing tie-wraps.
- Inspect the ground strap for a good connection and for good condition.
- Disconnect any battery chargers that are not protected against the current drain of the starting motor. Check the condition and the electrolyte level of the batteries, unless the engine is equipped with a maintenance free battery.
- Check the condition of the gauges. Replace any gauges that are cracked. Replace any gauge that can not be calibrated.

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Water Pump - Inspect

SMCS Code: 1361-040; 1361

A failed water pump might cause severe engine overheating problems that could result in the following conditions:

- Cracks in the cylinder head

- A piston seizure
- Other potential damage to the engine

Note: The water pump seal is lubricated by the coolant in the cooling system. It is normal for a small amount of leakage to occur as the engine cools down and parts contract.

Visually inspect the water pump for leaks.

Note: If engine coolant enters the engine lubricating system the lubricating oil and the engine oil filter must be replaced. This will remove any contamination that is caused by the coolant and this will prevent any irregular oil samples.

The water pump is not a serviceable item. In order to install a new water pump, refer to the Disassembly and Assembly Manual, "Water Pump - Remove and Install" or contact your Caterpillar dealer.